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Ultrasound Cavitation Versus Electromagnetic Stimulation on Abdominal Obesity after Vaginal Delivery

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Abstract

Introduction: *Abdominal obesity is prevalent in postnatal women; therefore, aesthetic modalities can help to manage obesity complications.*

Material and Methods: *sixty obese multiparous women, with marked abdominal obesity. They were split into two equal groups (A and B). (Group A) received high intensity focused electromagnetic stimulation on her abdomen for 30 minutes, twice weekly for 12 weeks. (Group B) receive high intensity focused ultrasound on her abdomen for 30 minutes, twice weekly for 12 weeks, Also, every patient in both group (A) and (B) was requested to perform moderate aerobic exercise program on treadmill for 30 minutes twice weekly for 12weeks.Simultaneously, each patient advised to follow a low caloric diet program prescribed by a special nutritionist throughout the treatment program (12 weeks). All subjects were evaluated before and after treatment through measuring body mass index, waist circumference, WHR, cholesterol level, triglyceride, HDL, LDL and Percent of body fat.*

Results: *The study's results indicated a non-statistically significant change in BMI, Waist circumference, WHR; cholesterol level, triglyceride, HDL, LDL and Percent of body fat across both groups before treatment. Also, a statistically significant change was detected ($p < 0.001$) in both groups post treatment in all variables. With the superiority of group.* ***Conclusion:*** *The electromagnetic stimulation and restricted diet plan were more effective on all variables more than Ultrasound cavitation and restricted diet plan.*

Keywords: *electromagnetic - ultrasound cavitation- abdominal obesity-vaginal delivery- obese women*

INTRODUCTION

Obesity has complex consequences, increasing risks for chronic diseases and complicated medical treatments. It also leads to economic burdens and affects quality of life, causing social isolation and discrimination (Azemi et al., 2025).

Obesity is one of the expanding challenges affecting our society's health and well-being. Up to 60% of individuals in many nations are currently considered overweight or obese, and by 2030, that number is expected to increase to up to 90% (Webber et al., 2014).

Abdominal obesity is a major contributor to metabolic syndrome and an autonomous risk indicator for a variety of non-communicable illnesses, including type 2 diabetes (T2DM) and cardiovascular diseases (CVD), and has a great impact on economic development (Dagne et al., 2021).

An elevated hazard of insulin resistance (IR), which could potentially attribute to dyslipidemia, is linked to abdominal obesity. IR continues to be progressing along with abdominal obesity, and later, disturbed glucose tolerance and impaired fasting glucose are also indicated. Ultimately, this leads to elevated blood glucose and cholesterol levels (Maced et al., 2014).

Many women who put on extra weight during pregnancy continue to keep much of that weight after giving birth. Postpartum weight retention following childbirth is one of the primary reasons of women's weight gain; this predisposes them to further weight retention, future obesity, excess weight, and major comorbidities such as T2DM, cancer, CVD, and hypertension (Stuart et al., 2016).

Pregnancy-related weight gain is mostly caused by natural physiological changes and restructuring of tissues. The pre-pregnancy body mass index (BMI) indicates the ideal weight gain. Consequently, certain weight gain ranges based on pre-pregnancy BMI are determined by the Institute of Medicine's (IOM) standards. Women are expected to reach their pre-pregnancy weight by the sixth week after giving birth. However, numerous studies indicate that between six months and two years after giving birth, 20 to 50% of women still retain significant amounts of the weight they gained through pregnancy (Haugen et al., 2019).
Magnetic stimulation has a track record of success in treating a wide range of medical conditions, including psychiatry, neurology, physiotherapy, and female incontinence. Additionally, the technology's application is regarded as somewhat safe because it is non-thermal and non-ionizing. Despite its great effectiveness, this technique is not as popular as electrical stimulation (Abulhasan et al., 2016).
Electromagnetic muscle stimulation (EMMS) devices induce rapid muscle contractions, enhancing strength and reducing waist circumference and subcutaneous fat thickness, making them effective for noninvasive body contouring (Gwinn et al., 2021).
ltrasound cavitation (UC) is practical procedure for mobilizing stored fat with the same efficiency of liposuction. This technique also has fewer side effects than liposuction since it is less invasive (Weiss et al., 2013).
In UC, cyclic sound pressure is applied at a higher frequency than the subject audiable threshold. Adipocytes are disrupted and a particular body area is reshaped by ultrasound fat cavitation (USFC) technique which is used to treat obesity. Fat cells are mechanically disrupted when low-frequency ultrasonic devices transmit ultrasonic energy through the skin. Generally, it is well tolerated due to its non-thermal action. Comparing USFC to invasive ultrasonic liposuction, the non-surgical technique may also be more cost-effective, lower risk, and less likely to result in obesity-related problems (Khedmatgozar et al., 2020).
A synergistic effect was achieved by combining these treatment methods for body contouring fat disruptor with UC, which was developed to eliminate or reduce undesired local subcutaneous fat. (Després et al., 2012).

MATERIALS AND METHODS

Participants

Sixty obese multiparous women, with marked abdominal obesity after six months from their last delivery were participate in this study. They were recruited randomly from the outpatient clinic of physical therapy at General Suez Hospital. They aged between 25 and 35) years old, their BMI was varied from (30 -35) kg/m2, their waist circumference was ranged from 90 to 105 cm, their waist hip ratio (WHR) was >0.85cm and they ranged in parity from two to four children.
A pilot study was used to determine the sample size. The unpaired t test was utilized to determine the significant difference in the mean difference in body fat percentage between the electromagnetic stimulation (19.96 ± 2.17) and ultrasound (9.93 ± 1.94) groups, with α=0.05, power of 80%, and an effect size of 0.65. Therefore, a sample size of 30 participants each group would be needed and increased to be 35 participants to overcome a 15% dropout rate (GPower 301 http:www.psycho.uni- duesseldorf.de). The mean ± standard deviation is used to express the results. The unpaired t-test was applied to compare the variables in the two groups. The paired t test was utilized to compare the data within the same group before and after treatment. Data analysis was done utilizing the SPSS computer program (version 19 windows). A P-value of ≤ 0.05 proved to be significant.

Procedures Evaluative procedure.

All data of all patients in the two groups (A&B) had been taken and recorded in data sheet before initiating the treatment program. Weight and height of all patients had been measured before and after the intervention and BMI is calculated. Waist and hip circumferences of every patient in the two groups had been measured before and after the intervention and waist hip ratio is calculated by dividing waist circumference (WC) on hip circumference (HC). The WC is the narrowest diameter measured between xiphoid process and iliac crest, while HC is the widest diameter over greater trochanter. The lipid profile in blood plasma was calculated for all patients in the two groups before and after the intervention as follows: Every patient sat on armchair, the anticubitios fossa had been cleaned with a cotton swap soaked in alcohol, then a blood Sample of 3 cm had been withdrawn from the anticubital. vein by a disposable sterilized syringe. Then the blood samples were kept in sterilized tubes. These tubes had been collected and sent instantly to the laboratory Center to be analyzed. Every patient in the two groups had been asked to use bio-electrical impedance analysis (In Body) before and after the intervention to measure her body composition to detect the percentage of Fat in her body. This study was approved by the Ethical Research Committee of the Faculty of Physical Therapy at Cairo University, Egypt. No: P.T.REC/012/005970.

Treatment procedure:

- **Group (A):**

This group comprised 30 patients. Every patient received high intensity electromagnetic Stimulation for 30 minutes on her abdomen, 2 times/week for 12 weeks. Also, each patient had been asked to perform moderate aerobic exercise program on treadmill machine for 30 minutes 3 times/week for 12 weeks. At the same time, each patient had been advised to follow a low caloric diet program prescribed by a special nutritionist throughout the treatment course. This procedure had been done as the Following: (1) The patient was instructed to lie in a supine position, with a white sheet covering her except for the treated area (her abdomen). To stop the spread of infection, the skin of her abdominal wall and the two applicators of the device were cleaned with a cotton piece soaked in alcohol. (2) After that, the physiotherapist had calibrated the device on the following parameters: Frequency: l00 Hz; Pulse width: 300 Ms; Intensity: according to patient's tolerance ranging from (1-7) TESLA. (3) After calibrating the device, the physiotherapist had been applied the two applicators of the device on patient's abdomen (on either side of the umbilicus) and fasten them with straps to prevent their movement during the treatment session, then, the apparatus had been switched on. After that the physiotherapist had started to increase intensity of electromagnetic stimulator gradually according to the patient's tolerance. The treatment session lasted 30 minutes. (5) After completing the treatment session, the apparatus had been turned off and two applicators of the device had been removed after that, the patient asked to perform moderate aerobic exercises program on treadmill machine for 30 minutes. (6) At the end, the patient advised to follow a low-calorie diet program throughout the treatment course (12 weeks).

- **Group (B):**

This group comprised 30 patients. Every patient received high intensity focused ultrasound on her abdomen for 30 minutes, 2 times/week for 12 weeks. Also, each patient asked to perform moderate aerobic exercise program on treadmill machine for 30 minutes, 3 times/week for 12 weeks. In the same time, each patient advised to follow a low caloric diet program prescribed by a special nutritionist throughout the treatment course (12 weeks).

This procedure had been done as the following:

(1) The patient was instructed to lie in a supine position, with a white sheet covering her except for the treated area (her abdomen). Then, the skin of her abdominal wall cleaned with a cotton piece soaked in alcohol while the transducer head of ultrasound device covered with a condom to avoid transferring of infection. (2) After that the physiotherapist calibrated the ultrasonic device on the Following parameters: Frequency: 40 KHz; Power: 30 Watt/cm2 (50-60Hz); Mode: pulsed mode. (3) After calibrating the device; a sufficient amount of Sono gel placed on the whole abdominal wall, then, the physiotherapist switched on the ultrasonic device and held the transducer head from its handle, then he putted the transducer head (treatment head) directly on the skin of the abdominal wall and start to move it in a circular movement over the whole abdomen except umbilicus. The treatment session lasted 30 minutes after that, the ultrasound device was turned off, and a cotton piece was utilized to clean the abdominal wall's skin (4) After the treatment sessions the patient asked to perform moderate aerobic exercises program on treadmill machine for 30 minutes. (5) At the end, the patient advised to follow a low caloric diet program during the treatment program (12 Weeks).

RESULTS

Subject characteristics

In group A, the mean values of age and height were 30.83 ± 2.75 years and 165.83 ± 5.11 cm, respectively. While they were 30.63 ± 2.63 years and 167.63 ± 6.43 cm in group B, respectively. There was no statistically significant change in age (t= 0.288, p= 0.774) and height (t= -1.200, p= 0.235) across both groups (Table (1))

Table (1): Participants' demographic data of both groups.

	Group A (n= 30)	Group B (n= 30)	t value	p value
Age (yrs.)	30.83 ± 2.75	30.63 ± 2.63	0.288	0.774
Height (cm)	165.83 ± 5.11	167.63 ± 6.43	-1.200	0.235

Data are represented as mean ± SD.
NS= p> 0.05= not significant.

Efficacy of treatment on weight, BMI, WC, WHR, % of Body Fat, cholesterol, Triglycerides, HDL and LDL,
1. Weight (kg)

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	94.93 ± 5.69	76.33 ± 4.94	18.60 kg	↓ 19.59%	Highly Significant (p=0.001)
Group B	98.07 ± 6.60	87.93 ± 6.12	10.14 kg	↓ 10.34%	Highly Significant (p=0.001)

2. Body Mass Index (BMI, kg/m2):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	34.49 ± 0.63	27.80 ± 1.11	6.69	↓ 19.40%	Highly Significant (p=0.001)
Group B	34.81 ± 0.18	31.22 ± 0.69	3.59	↓ 10.31%	Highly Significant (p=0.001)

3. Waist Circumference (WC, cm):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	95.77 ± 15.27	76.90 ± 10.13	18.87 cm	↓ 19.70%	Highly Significant
Group B	97.77 ± 6.89	89.10 ± 6.52	8.67 cm	↓ 8.87%	Highly Significant

4. Waist-to-Hip Ratio (WHR):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	0.889 ± 0.011	0.791 ± 0.016	0.098	↓ 11.02%	Highly Significant
Group B	0.887 ± 0.015	0.863 ± 0.014	0.024	↓ 2.71%	Highly Significant

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5. Percent Body Fat (%):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	41.39 ± 4.26	22.05 ± 3.28	19.34	↓ 46.73%	Highly Significant
Group B	41.65 ± 1.85	31.28 ± 1.71	10.37	↓ 24.90%	Highly Significant

6. Total Cholesterol (mg/dL):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	223.27 ± 6.94	194.97 ± 3.16	28.30	↓ 12.68%	Highly Significant
Group B	225.30 ± 3.98	211.50 ± 18.28	13.80	↓ 6.13%	Highly Significant

7. Triglycerides (mg/dL):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	182.93 ± 10.74	143.83 ± 3.99	39.10	↓ 21.37%	Highly Significant
Group B	181.40 ± 8.15	167.93 ± 8.92	13.47	↓ 7.43%	Highly Significant

8. High-Density Lipoprotein (HDL, mg/dL):

	Before Treatment	After Treatment	Mean Increase	% Change	Significance
Group A	46.93 ± 4.20	66.70 ± 3.37	+19.77	↑ 42.13%	Highly Significant
Group B	45.83 ± 4.14	55.90 ± 3.34	+10.07	↑ 21.97%	Highly Significant

9. Low-Density Lipoprotein (LDL, mg/dL):

	Before Treatment	After Treatment	Mean Reduction	% Change	Significance
Group A	146.03 ± 8.98	103.53 ± 6.24	42.50	↓ 29.10%	Highly Significant
Group B	148.73 ± 5.96	136.80 ± 6.18	11.93	↓ 8.02%	Highly Significant

DISCUSSION

Obesity is a multifaceted public health issue, affecting health based on fat distribution, particularly abdominal fat, which is linked to chronic diseases such as hypertension and diabetes (Pena et al., 2017). Abdominal obesity is a key component of metabolic syndrome and a risk indicator for various non-communicable illness including cardiovascular diseases (CVD) and type 2 diabetes (T2DM), significantly affecting economic development. (Dagne et al., 2021).

Childbearing women are the second group to suffer from a significant increase in body weight during their reproductive years. In midlife and the postmenopausal period, overweight and obesity may be predominantly caused by gestational and postpartum weight gain. Overweight and obesity are worldwide public health issues and are key risk indicators for CVD, dyslipidemia, and T2DM. Epidemiological studies indicated that only 20% of obese individuals accomplish a substantial risk by reducing weight loss by less than 10%, with dietary changes, physical activity, and behavioral lifestyle changes. Pregnancy-related weight increase is strongly correlated with the development of obesity in women during the postpartum life cycle, midlife, and postmenopausal period (Hruby et al., 2017).

Electromagnetic muscle stimulation (EMMS) devices induce rapid muscle contractions, enhancing strength and reducing waist circumference and subcutaneous fat thickness, making them effective for noninvasive body contouring (Gwinn et al., 2021).

High-intensity focused ultrasound (HIFU) and comparatively low-intensity/low-frequency non-thermal ultrasound are the two main types of ultrasound utilized for body sculpting. A low frequency is selected for non-thermal ultrasound to enhance the possibility of cavitation while producing minimal heat through absorption processes. The ultrasonic might be highly focused to limit the cavitation impacts to the ultrasonic beam's focal zone. Health Canada has licensed low intensity non-thermal (mechanical) ultrasound, and the FDA is reviewing it for reducing waist, hip, and thigh circumference. Patients who require skin tightening may not benefit from this technique because it does not rely on heating as its primary mechanism of action. Patients with localized adiposity who are not obese (body mass index < 30) may benefit from non-thermal ultrasound. (Ascher, 2010).

The study aims to compare the effectiveness of ultrasound cavitation (UC) versus electromagnetic stimulation in reducing abdominal obesity, general obesity, lipid profile and whole body composition in women after vaginal delivery. Given the increasing prevalence of obesity and its associated health risks, postpartum weight retention remains a significant concern. This research seeks to evaluate which method offers superior results in terms of fat reduction, muscle toning, and overall body contour improvement. By assessing the impact of these non-invasive treatments, the study aspires to provide valuable insights for physical therapy interventions that can enhance postpartum weight management strategies.

A study evaluated the effects of a medical device using electromagnetic fields on overweight and obese patients with a BMI > 25 Kg/m2 for 6 weeks, focusing on fat reduction. After 12 sessions of treatment, an average reduction in visceral fat of 8.2% and a reduction in subcutaneous fat of 4.1% were observed. The treatment also led to a modest average weight loss of 1.6 kg over the course of the sessions, achieved without any restrictive diets or significant lifestyle changes. This suggests that the device can facilitate weight loss in a non-invasive manner (Beilin et al., 2018).

The effectiveness of an innovative therapeutic approach that uses high intensity focused electromagnetic fields (HIFEM) to reduce fat and strengthen the muscles in the gluteal and abdominal regions was assessed in a study by Giesse (2021). Four 30-minute treatments on the abdomen and/or buttocks were administered to 14 individuals, ages 23 to 49 (mean age: 33.2 years). Ultrasound measurements taken two months after the treatments revealed an average increase of 26.1 percent in the rectus abdominis muscle's thickness and a 15.7 percent decrease in subcutaneous adipose tissue. The patients' average reduction in the abdominal circumference was 2.84 cm. The patient's satisfaction was 87.5 percent just after the last session and 100 percent eight weeks later.

In a study by Duncan and Kormeca (Duncan & Dinev, 2020), HIFEM field device was tested on 33 participants, both men and women, who had abdominal obesity. Over a span of two weeks, the participants underwent four 30-minute HIFEM treatment sessions. The results indicated a significant decrease in waist circumference (WC) and an improvement in abdominal muscle thickness, with participants reporting visible abdominal contouring. This study highlights the potential effectiveness of HIFEM in reducing abdominal obesity and enhancing muscle tone (Duncan & Dinev, 2020).

Another study examined the effects of electromagnetic muscle stimulation on 40 overweight participants. The participants received electromagnetic stimulation once a week for eight weeks. The results indicated significant reductions in WC and body fat percent, as well as an increase in muscle mass. This study further supports the notion that electromagnetic stimulation can contribute to fat reduction and muscle strengthening in overweight individuals and thus improve waist circumference (Swinton et al., 2022).

Electromagnetic stimulation (Meng et al., 2024) has demonstrated superior effects over ultrasound stimulation in reducing abdominal obesity, particularly in WC and waist-hip ratio (WHR). This advantage is attributed to several physiological mechanisms that enhance fat reduction and muscle engagement. One key mechanism is muscle activation, as EMS effectively stimulates abdominal muscles, increasing muscle strength and thickness, which contributes to fat loss. Studies have shown a significant rise in muscle activity and thickness following EMS intervention (Yoo et al., 2019). Additionally, EMS is correlated with a notable decrease in subcutaneous abdominal fat, with research indicating significant decreases in WC and WHR after EMS application (Kim et al., 2015). Another important factor is improved blood circulation, as EMS enhances blood flow to the abdominal region, which may facilitate fat metabolism and improve overall body composition (Lee & Tae, 2014). While both EMS and ultrasound stimulation have been explored as modalities for addressing abdominal obesity, the literature presents mixed perspectives on their efficacy. Some studies favor EMS due to its ability to promote muscle engagement and fat reduction, while others highlight the effectiveness of ultrasound in targeting adipose tissue. A comprehensive synthesis of these findings provides a clearer understanding of their comparative benefits.

A randomized control trial showed the impact of pulsed electro-magnetic field (PEMF) Therapy and traditional physiotherapy on lipid profile of 40 subjects was demonstrated. The research involved 40 participants divided into two groups; group 1: Received PEMF therapy alongside aerobic and resistive exercises, group 2: Underwent only aerobic and resistive exercises without PEMF therapy. After a three-week intervention period, the study found that the combination of PEMF therapy with traditional physiotherapy (Group 1) was more efficient in reducing total cholesterol, low-density lipoprotein (LDL), and high-density lipoprotein (HDL) levels in comparison to traditional physiotherapy alone (Group 2) (Deshmukh et al., 2021).

A study evaluated the effects of a medical device using electromagnetic fields on overweight female patients; 38 patients' candidate with a BMI > 25 Kg/m2 for 6 weeks, twice a week. After 12 sessions, a scanner imaging study revealed an average decline in visceral fat of 8.2% and a reduction in subcutaneous fat of 4.1% after treatment (Beilin et al., 2018).

While direct comparative studies between US therapy and EM are scarce, existing research highlights the efficacy of each modality in body contouring. Ultrasound therapy primarily targets fat reduction, whereas EM induces supramaximal muscle contractions, leading to muscle hypertrophy, strengthening and fat loss. Studies have reported significant increases in muscle thickness, ranging from 14.8% to 15.4%, following HIFEM treatments (Bruce Katz,2021).

Limitations of the study:

This study has several limitations that may affect the interpretation and applicability of its findings. The small sample size is a key limitation that hinders the result's applicability to a larger population. Alongside, the short duration of the intervention may not have been sufficient to capture the long-term effects of electromagnetic and ultrasound stimulation on body composition. Another significant constraint is the lack of control for lifestyle factors including diet, physical activity, and individual metabolic differences, which may have influenced the outcomes and made it difficult to isolate the direct impact of the interventions.

Moreover, variability in individual responses presents another challenge, as changes in metabolism, body composition, and adherence to the treatment protocols could have contributed to inconsistencies in the results. Measurement limitations also play a role, as the accuracy and reliability of body composition evaluative methods, such as bioelectrical impedance analysis, may introduce errors in the reported findings. Finally, the ongoing impact of the observed effects is still unknown due to the lack of long-term follow-up, limiting the study's ability to assess the lasting impact of the interventions.

Clinical implications

The research presents strong evidence advocating for the integration of this combined high intensity electromagnetic stimulation and low caloric diet with exercise protocol into standard physiotherapy practices for obese postnatal women. The notable enhancements in weight, lipid profile, WC, WHR underscore the intervention's potential to alleviate the adverse impacts of abdominal obesity and generally improve wellness in these patients.

CONCLUSIONS

The Electromagnetic Stimulation (Group A) showed significantly superior outcomes compared to Ultrasound Cavitation (Group B) across all measured variables: Greater loss in weight, BMI, WC, WHR, body fat, LDL, triglycerides, and total cholesterol. Greater increase in: HDL (good cholesterol). This suggests that electromagnetic stimulation is more effective for managing postnatal abdominal obesity and improving lipid profiles.

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