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Effect of Ultrasound Cavitation versus Electroacupuncture on Sex Hormones in Obese Infertile Women with Polycystic Ovarian Syndrome: A Randomized Controlled trial

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ABSTRACT

Background: Polycystic Ovarian Syndrome (PCOS) is one of the most prevalent metabolic and reproductive disorders that have been linked to hyperandrogenism, and anovulatory infertility in females of reproductive age.

Objective: The aim of the work was to compare the influence of electroacupuncture and ultrasonic cavitation on sex hormones in obese, infertile PCO patients.

Patients and Methods: This prospective, single-blind, randomized controlled study included a total of forty obese, infertile PCO women, selected from the Department of Obstetrics and Gynecology, Aga Central Hospital, Egypt. The participants were divided randomly into two groups; **Group (A)** included twenty infertile, obese PCO women who had been treated with ultrasound cavitation on the abdomen twice a week for three months. **Group (B)** consisted of twenty infertile, obese PCO women who received electroacupuncture twice a week for 3 months. BMI, WHR, LH, FSH, testosterone, and serum progesterone levels were evaluated at baseline and after the study for both groups.

Results: Statistical analysis revealed a highly significant decrease in BMI, WHR, LH, the LH/FSH ratio, and testosterone, in addition to a significant raise in FSH and serum progesterone in the two groups, A and B, after treatment when compared to pre-treatment ($P \leq 0.001$). Between the two groups (A and B) pre- and post-treatment, there were no statistically significant differences in the measured variables ($p > 0.05$).

Conclusion: It could be concluded that both ultrasound cavitation and electro acupuncture are efficient therapies for treating obese infertile patients with PCOS.

Keywords: Electroacupuncture, Ultrasound Cavitation, Poly Cystic Ovarian Syndrome, Sex hormones, Obese infertile patients.

INTRODUCTION

A percentage of 6–10% of women of reproductive age are affected by polycystic ovarian syndrome (PCOS), which is considered a prevalent metabolic and endocrine disorder influencing women within the previously mentioned scope [1]. It is associated with anovulatory disorders, insulin resistance, overweight, hyperandrogenism, and infertility, as well as a higher risk of several comorbid conditions, such as dyslipidemia, the metabolic syndrome (MS), type 2 diabetes mellitus (DM2), a persistent low-grade inflammatory state, cardiovascular disease, and a higher mortality rate [2, 3].

A decrease in sex hormone binding globulin (SHBG) and an increase in serum levels of androgens and luteinizing hormone (LH) are endocrine characteristics of PCOS. The disruption of ovarian steroid hormones' feedback to both the hypothalamus and pituitary results in an-ovulation. This disruption affects the pulsatile nature of gonadotropin-releasing hormone (GnRH), increased luteinizing hormone (LH) pulses over the follicular stimulating hormone (FSH) pulses in the pituitary gland, resulting in a high LH/FSH ratio that disturbs ovulation[4].

Anovulatory infertility is most caused by PCOS. A percentage ranges from 90 % to 95 % of women who present to infertility specialized medical clinics diagnosed with anovulation have PCOs. Ninety percent of them are overweight. Obesity, on its own, aggravates infertility, decreases the efficiency of infertility treatment, and increases the probability of miscarriage [5].

Obesity appears to be closely related to PCOS; approximately 60% to 70% of PCOS women are obese. PCOS obesity is associated with an android appearance (truncal obesity), which is defined by increased abdominal adiposity and an increase in the waist-to-hip ratio (WHR) (>0.88). Obesity, particularly abdominal adiposity, may induce insulin resistance and the associated hyperinsulinemia, which may have a contribution

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to developing the hyperandrogenism in PCOS women [6].

There was a debate in terms of the convenient body mass index (BMI) limit for auxiliary reproduction therapies. Weight should ideally be optimized prior to pregnancy. Weight loss is thus the first line of treatment for ovulation induction prior to the use of any chemical agents [7].

Ultrasound cavitation (UC), commonly referred to as "fat cavitation," is a technique for dealing with subcutaneous adipose tissue (SAT), particularly for eliminating subcutaneous fat and reshaping a specific body region. It is favored for reducing obesity-related problems[8]. The cavitation effect of reducing regional fat distributions results in lower levels of both total testosterone and LH/FSH ratio, a greater regular menstrual cycles rate, higher rates of ovulation, and thus improved infertility and an increased pregnancy rate in obese PCO women [9-10].

Electro-acupuncture (EA) is a therapeutic technique in which needles are inserted into certain points and connected to electrical current stimulation. By adjusting the electrical current, amplitude, and frequency, it has the advantage that it is capable to assess stimulation more objectively as well as control it more accurately [11].

It was proven that electroacupuncture regulates hypothalamus, pituitary, and ovarian functions, improves follicle development as it decreases the abnormal elevated levels of luteinizing hormone (LH) in circulation, that influence both the LH/FSH ratio and testosterone levels, and hence improves infertility and pregnancy rates [11].

Because of the negative impact of excessive adipocytes on the clinical manifestations of obese PCO women, UC and EA are supposed to reduce abdominal obesity, improve ovarian function, and restore hormonal homeostasis in PCO women [9,11].

To our knowledge, no previous research has compared the effects of UC and EA on weight loss and alterations in sex hormones in infertile, obese PCO women. So, this study was carried out to differentiate between the effects of UC and EA on sex hormones in obese, infertile PCOs women, hypothesising that there would be no difference between the effects of both modalities.

MATERIALS AND METHODS

This prospective, single-blind, randomized controlled study included a total of forty obese, infertile PCO women, selected from the Department of Obstetrics and Gynecology, Aga Central Hospital, Aga, Egypt. This study was conducted between May 2021 and January 2022.

All participants had to meet at least two of the Rotterdam diagnostic criteria for PCOS which include clinical hyperandrogenism (acne or seborrhea), and the presence of 8 or more cystic follicles (9 mm in diameter) or ovarian volume >10 ml on trans-vaginal scanning [2], as confirmed by the gynecologist. Their age ranged from 20 to 35 years, their BMI ranged from 30-40 kg/m^2 and their waist hip ratio was > 0.80.

Exclusion Criteria:

Patients with diabetes mellitus, thyroid dysfunction, concurrent cardiovascular problems, cardiac arrhythmia, or patients with pacemakers, renal or liver dysfunction, or malignancies, as well as other causes of infertility like tubal adhesions and uterine anomalies.

The patient's demographic data included age, height, weight; BMI, WHR, medical history, and history of menstruation were collected and recorded on a data sheet.

The included subjects were divided randomly into two groups (A and B), utilizing the sealed envelope method. Patients were positioned in different groups in accordance with the cards which were chosen by an external researcher who was unaware of the study's methods. **Group (A)** included twenty infertile, obese PCO women who had been treated with ultrasound cavitation on the abdomen twice a week for three months. **Group (B)** consisted of twenty infertile, obese PCO women who received electroacupuncture twice a week for 3 months.

The two groups, A and B, underwent the prescribed medical therapy by the gynecologist and the hypocaloric diet (1200 kcal/day) that was prescribed by the nutrition specialist for 3 months (Figure 1). After randomization, there was no dropout among the participants.

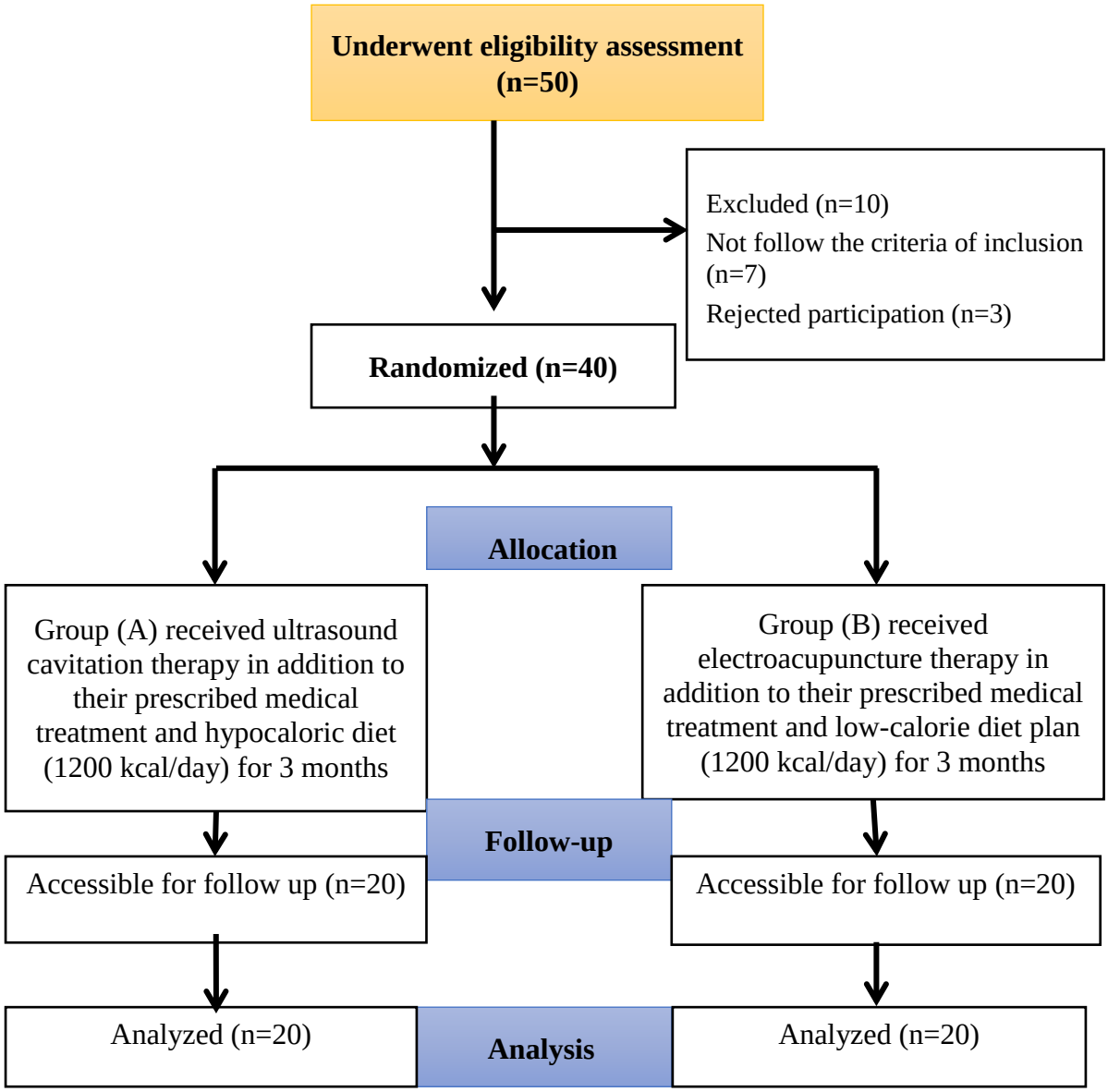

Fig. (1): Flow chart of the study.

Procedures:

All women in both group A and group B were instructed to adhere to the same medication regimen (metformin) as prescribed by the gynecologist and the same hypocaloric diet in which the daily intake was 1200 kcal that prescribed and modified every 2 weeks by a nutrition specialist for 3 months. Depending on the age of participants and their dietary habits, the menu changed. It had a low amount of fat (20–25%), a lot of complex carbohydrates (50–60%), and adequate protein intake (25–30%) from vegetarian sources and animal. Consume complex CHO (carbohydrates) that are low in glycemic load and have high fiber content, such as oats, whole grains, vegetables, and fresh seasonal fruits. Items high in saturated fats, on the contrary, such as fried foods and bagged meats, were advised to be consumed in moderation [12]. The nature, aim, and advantages of each therapeutic approach should be described to each woman before applying ultrasound cavitation or electroacupuncture for groups (A) and (B), respectively, to acquire their trust and collaboration during the sessions of treatment.

Ultrasound cavitation: Treatment via ultrasound cavitation was carried out to each patient in Group A for two sessions per week for a duration of 3 months. Each woman was given the instruction to empty her bladder prior to initiating the session of treatment to make certain that she would be at ease and comfortable throughout the session. Each patient's abdominal region was divided transversally into three parts from a standing position: Part I: from the xiphoid process to three centimeters on top of the umbilicus; Part II: from three centimeters over the umbilicus to two centimeters beneath the umbilicus; and Part III: from two centimeters beneath the umbilicus to the pubic bone. Afterwards, every part was then split vertically into two segments, right and left relative to linea alba, which ultimately results in a total of six abdominal segments.

The skin which is on the abdominal wall anteriorly had been cleaned using alcohol before application of conducting medium (gel) to the ultrasound device's cavitation head. The device was then turned on, the cavitation program was set at a

frequency of 40 kHz, and the intensity percentage had been adjusted to 50% for the initial 12 sessions and to 75% for the last 12 sessions, for 30 minutes. Afterwards, the cavitation head was slowly moved in small circular motion over each abdominal part for five minutes. Ultimately, after finishing the six abdominal segments, the skin was cleaned with cotton. The ultrasonic therapy session for the six abdomen parts lasted 30 minutes in total [9].

Electroacupuncture: Each patient in Group B received electroacupuncture treatment twice a week for three months. Alcohol-soaked cotton was used to clean the skin over the applied area. The sterilized, disposable needles (30 mm in length and 0.25 mm in diameter, made in China) were inserted at a depth of 15-40 mm to achieve de qi sensation at acupuncture points that provide both the ovary and uterus by somatic innervation of (Th12-L2 and S2-S4), while the patient lied in a prone position [13]. Then the women were asked to lie supine and the needles had been inserted at acupoints that are commonly used to reduce abdominal obesity: Tianshu (ST-25): 2 cun lateral to the umbilicus (CV 8), in the middle of the abdomen. Daheng (SP-15): It is four inches laterally from the umbilicus' center, laterally to the rectus abdominus. Qihai (CV-6) is located between CV 5 and CV 7, about 1.5 inches below CV 8 (umbilicus). Zhongwan (CV-12): centered between CV 8 (umbilicus) and CV 16 and located 4 inches above CV 8. Zusanli (ST-36) which is located lateral to the anterior tibia board by one finger width, 3 inches just below ST 35. Then, the needles were connected to electric stimulation (No. 18 Huatuo Rd., Suzhou New District, China) with a low frequency of 2 Hz and a pulse width of 0.5 ms for 30 minutes for each side, adjustment of intensity was carried out in order to provide localized muscle contractions without inflicting pain [14, 15].

Outcome measures:

Body mass index (BMI) and waist hip ratio (WHR):
The body weight and height of each woman in both groups had been calibrated by a universal scale of weight and height before and after the completion of the study program to calculate the BMI in accordance with the following equation: $\boldsymbol{BMI = \frac{Weight}{Height^2}}$ **(Kg/m²)** [16].

The waist-hip ratio of all the women in the two groups, A and B respectively, was assessed both before and after the study by using soft tape. It was estimated via division of the circumference of the waist by the circumference of the hip [17].

Biochemical assays:

Each woman in both groups (A and B) had a sample of 5 cm of venous blood taken from the antecubital vein in the forearm twice: once, at the end of her 2nd or 3rd day of the menstrual period before beginning her treatment regimen, and once, on the same days, at the end of her regimen of treatment (after 3 months). After the withdrawal, it was centrifuged two hours later. Serum was stored at-20°C and tested for LH, FSH, LH/FSH ratio, and testosterone using Tosoh-Japan kites [9].

Ovulation timing was also determined by measuring serum progesterone levels. It was measured by Tosoh-Japan kites at the phase of mid-luteal (21-23 days of the cyclic menstruation) for all patients in the two groups, A and B, before and after the program of treatment (after 3 months). An increase in progesterone levels after ovulation indicates successful ovulation. Normally, its level was usually >7 ng/ml at the mid-luteal phase [18].

Ethical consent:

This study was ethically approved by Institutional Review Board, Faculty of Physical Therapy, Cairo University (No 012/003187). Written informed consent of every participating woman was obtained after explaining the research's goals and her ability to withdraw at any moment. The protocol was prospectively registered on Clinical Trials.gov (No. NCT04875312). The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing.

Sample size estimation:

G*Power statistical software (version 3.1.9.2; Universitat Kiel, Germany) was used to determine the optimal size of the sample to conduct the two groups comparative study. The minimum number of participants needed for every group was 20, which was determined according to a pilot study on 5 individuals in each group. Calculations were accomplished via utilizing: α=0.05, power80%, size of effect= 0.95 and ratio of allocation N2/N1=1.

Statistical Analysis

The data was collected and analyzed statistically by utilizing the Statistical Package for Social Sciences (SPSS) (IBM SPSS, Chicago, IL, USA) (version 25) for Windows. The Shapiro-Wilk test was used to verify that the data followed a normal distribution. Homogeneity of variances across groups was carried out using Levene's test. Descriptive statistics, including mean ± SD, were quantified for all variables. An unpaired t-test was carried out for the comparison of mean values between groups before and after treatment. Mean values before and after treatment of every group were compared using a paired t-test. For all statistical tests, a value of p 0.05 was chosen as the level of significance.

RESULTS

Table (1) represents the descriptive statistics for the patients' demographic data for both groups (A&B). According to the results of an unpaired t-test, at baseline, there was no significant difference between the two groups in the mean values of age, weight and height (p> 0.05). Chi square revealed that there was non- significant difference between both groups in the menstrual history items (frequency, amount, regularity, and dysmenorrhea).

Table (1): Patients' demographic data for both groups (A&B) at the baseline

Variables	Group A Mean ±SD	Group B Mean ±SD	T value	P value
Age (years)	25.65±4.55	24.65±3.28	0.796	0.431
Weight (kg)	109.35±11.73	104.60±5.19	1.65	0.106
Height (cm)	176.75±8.11	172.85±4.80	1.85	0.072
History of menstruation:			**$\chi 2$**	**P value**
Frequency (n, %)				
-Normal	8(40%)	7(35%)		
-Oligomenorrhea	12(60%)	13(65%)	$\chi 2$= 0.106	0.744
-Amenorrhea	0(0%)	0(0%)		
Amount (No of pads per day) (n, %)				
-Average (2-3 pads/day)	10(50%)	12(60%)		
-Heavy (≥ 4 pads/day)	6(30%)	5(25%)	$\chi 2$= 0.415	0.812
-Scanty (1 pad/day)	4(20%)	3(15%)		
Regularity (n, %):				
-Regular	13(65%)	11(55%)	$\chi 2$= 0.106	0.744
-Irregular	7(35%)	9(45%)		
Dysmenorrhea (n, %):				
- Mild pain	11(55%)	12(60%)		
-Moderate pain	7(35%)	5(25%)	$\chi 2$= 0.576	0.749
-Severe pain	2(10%)	3(15%)		

SD: standard deviation**, $\chi 2$:** Chi square value, **P value=** Probability**, N.S=** Not- Significant at p> 0.05

Within and between group's analysis:

As presented in Table 2, the mean values of both groups' (A and B) body mass index (BMI) and waist-to-hip ratio (WHR) significantly decreased after treatment compared to before treatment (p≤0.001*). However, when comparing between both groups (A and B), there had been no significant statistical change before or after the study (p> 0.05). But the decreased percentage of BMI was (21.89% and 18.4%), and that of WHR was (12.5% and 11.8%) for groups A and B, respectively, which was in favor of group A. As presented in Table 3, a highly statistically significant reduction was evident in the mean values of LH, LH/FSH, and testosterone and a high statistically significant increase in the mean values of FSH and progesterone in the two groups, A and B, after treatment compared to before treatment (p≤0.001*). When both groups (A and B) were compared, there was no statistically significant difference in any of the measured hormones (p> 0.05). However, the percentage of decrease in LH and LH/FSH ratio was (60.2% and 57.8%), (64% and 60.2%), and the percentage of increase in FSH was (10.01% and 4.4%), for groups A and B, respectively, which was in favour of group A, and the percentage of increase in serum progesterone was (597% and 765%), for groups A and B, respectively, which was in favour of group B.

Table (2): BMI and WHR pre and post treatment for both groups (A and B)

Variables	Group A Mean ±SD	Group B Mean ±SD	T value	P value [b]
BMI (kg/m^2)				
Pre- treatment	35.40±2.47	34.58±1.54	1.25	0.216 (NS)
Post treatment	27.65±1.03	28.01±0.86	1.20	0.236 (NS)
Mean difference	7.75	6.58		
% Change	21.89%	18.4%		
T value	23.25	18.99		
P value [a]	≤0.001*	≤0.001*		
WHR				
Pre- treatment	0.905±0.03	0.885±0.04	847	0.402(NS)
Post treatment	0.792±0.02	0.786±0.01	1.085	0.285(NS)
Mean difference	0.113	0.099		
% change	12.5%	11.18%		
T value	10.052	10.89		
P value [a]	≤0.001*	≤0.001*		

[a] : within group value, **[b]**: between group value, **N.S=** Not-Significant at p> 0.05**, *Significant** at P< 0.05**; **p< 0.01=** highly significant.

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Table (3): Hormonal profile pre and post treatment for both groups (A and B).

Variables	Group A Mean ±SD	Group B Mean ±SD	T value	P value [b]
LH (IU/l)				
Pre- treatment	10.19±2.53	9.18±2.22	1.065	0.293(NS)
Post treatment	4.05±0.98	3.87±0.95	0.571	0.571(NS)
Mean difference	6.14	5.31		
% change	60.2%	57.8%		
T value	15.102	9.228		
P value [a]	≤0.001*	≤0.001*		
FSH (IU/l)				
Pre- treatment	3.98±0.98	4.09±0.97	0.256	0.800(NS)
Post treatment	4.38±0.99	4.27±0.98	0.237	0.814(NS)
Mean difference	0.4	0.18		
% change	10.01%	4.4%		
T value	10.3	9.33		
P value [a]	≤0.001*	≤0.001*		
LH/FSH ratio				
Pre- treatment	2.60±0.35	2.41±0.32	1.81	0.078(NS)
Post treatment	0.93±0.12	0.96±0.17	0.646	0.522(NS)
Mean difference	1.67	1.45		
% change	64%	60.2%		
T value	25.6	17.6		
P value [a]	≤0.001*	≤0.001*		
Serum Testosterone (ng/dl)				
Pre- treatment	10.78±1.47	10.74±1.77		
Post treatment	3.23±0.32	3.21±0.72		
Mean difference	7.55	7.53	0.078	0.939(NS)
% change	70%	70.1%	0.092	0.927(NS)
T value	36.312	20.154		
P value [a]	≤0.001*	≤0.001*		
Serum Progesterone (ng/ml)				
Pre- treatment	1.33±0.32	1.03±0.23		
Post treatment	9.28±0.63	8.91±0.75	1.675	0.102(NS)
Mean difference	7.95	7.88	1.687	0.100(NS)
% change	597%	765%		
T value	58.147	61.30		
P value [a]	≤0.001*	≤0.001*		

[a] : within group value, **[b]:** between group value**, N.S=** Not-Significant at p> 0.05, ***Significant** at P< 0.05**; **p< 0.01=** highly significant.

DISCUSSION

In addition to being the leading cause of anovulatory infertility in reproductive-aged women, (PCOS) is one of the most significant endocrine disorders impacting this population [19]. The current study was aimed to compare the effects of ultrasonic cavitation and electroacupuncture on sex hormones in infertile, obese PCO women.

Regarding the anthropometric measurements, within-group comparison results revealed significant statistical declines in both body mass index and waist-hip ratio post-treatment in the two groups, A and B respectively, in comparison to pre-treatment. When comparing both groups, there had been no discernible difference between the two groups (A and B) pre- and post-study, but there was a higher

percentage of change (more reduction of BMI and WHR) in group A than in group B.

Both groups received a hypocaloric diet (1200 kcal/day) and metformin. It has been demonstrated that the hypocaloric diet is the most effective method of weight loss in obese PCO patients since it enhances hormone homeostasis and regulates menstruation [20, 21]. It was also reported that metformin alleviates endocrine abnormalities, controls ovarian function, and effectively helps obese PCO women to lose their weight [22].

The non-destructively thermal heating of adipose tissue caused by ultrasound cavitation, which speeds up the body's natural lipolysis processes and disrupts the adipocytes' own phospholipid layer with a consequent loss of about an inch in the treated area, is responsible for the significant reduction of BMI and WHR in the ultrasound group [23].The beneficial effect of cavitation in reducing weight, abdominal fat thickness and hence reshaping the body in obese women was approved by numerous previous studies [24, 25].

The current study's findings agreed with those of **Hamdy *et al.*** [12], who investigated the impact of ultrasound cavitation on obese PCO patients and found that UC was successful in lowering BMI and WHR in those patients and concluded that PCOS women with abdominal obesity could adopt UC as a complementary method for weight loss. Furthermore, **Mekawy and Omar** [9] reported that after 4 months of treatment, a low-calorie diet coupled with ultrasonic cavitation and exercise induced a considerable reduction in weight of body and visceral fat more than exercise and hypocaloric diet only.

In contrast, the current results disagreed with **Amr & Akram** [26], who studied the impact of ultrasound cavitation in contrast to cryolipolysis on patients with central obesity and concluded that both cavitation and cryolipolysis are effective in reducing central obesity but with mild better effect in favor of cryolipolysis.

The significant reduction of anthropometric measures in the electroacupuncture group can be attributed to the fact that the electroacupuncture significantly increases PGC-1 expression, improves mitochondrial function, and restores healthier levels of fatty acid oxidation, all of which help to reduce body weight, BMI, and WHR [27]. These findings were supported by many previous studies, which summarized that electroacupuncture is one of the most effective therapies for treating obesity because it can regulate the different metabolic processes, enhance fat decomposition, lower blood triglyceride levels, and result in weight loss [15, 28, 29].

Regarding the hormonal analysis results of this study, an obvious reduction of testosterone, LH hormone, and LH/FSH ratio was evident and a significant increase of FSH and serum progesterone hormones in both groups (A and B) after treatment compared to before treatment. No significant change between both group A and group B was evident either before or after study, while the percentage of decrease in LH, the LH/FSH ratio, and the percentage of raise in FSH were higher in group A than in group B, and the percentage of increase in serum progesterone was higher in group B than in group A.

Regarding the UC group, the significant changes in all measured hormones can be attributed to the fact that UC damages fat cell membranes, results in fat cell lysis, speeds up the body's lipolysis processes, and subsequently improves hormonal profiles (higher rates of regular menstrual cycles, higher rates of ovulation, lowered LH/FSH ratios and overall testosterone levels in obese PCO women [9].

The findings of the current study agreed with **Mekawy and Omar** [9], who found that the combination of ultrasonic cavitation, exercise, and a calorie-restricted diet led to greater improvements in hormone and menstrual imbalances, as well as an increased likelihood of pregnancy, compared to the combination of exercise and a calorie-restricted diet individually.

Also, **Hamdy *et al.*** [12] illustrated that in obese women with PCOs, US was correlated with a higher rate of ovulation, a rising rate of regular menstrual cycle, and a lower level of fasting insulin and total testosterone.

The significant improvement in the EA group's hormonal profile can be attributed to EA's inhibition of sympathetic nervous system hyperactivity and the high impedance of blood flow of uterine arteries, which increased blood flow and decreased sympathetic vasoconstrictor fibers activity which innervate the uterus, were the results of a high uterine arterial blood flow impedance, resulting in improved hormonal homeostasis, regulated menstrual cycle, and improved ovulation, explaining the better improvement in serum progesterone level in the EA group [13].

The findings of this study concurred with those of **Stener-Victorin *et al.*** [30], who studied the electro-acupuncture impacts on an-ovulation in PCO patients and found that there was a considerable decline in testosterone and LH/FSH ratios and concluded that EA could be utilized to supplement the pharmacological stimulation of ovulation in women diagnosed with PCOS who only had mild metabolic abnormalities.

As well, **Jedel *et al.*** [14] studied how electroacupuncture (EA) and exercises affected oligo-amenorrhea and hyperandrogenism in PCO patients, and they explored that EA with exercise led to significantly lowered LH, testosterone, and the LH/FSH ratio, as well as an increase in menstrual frequency, and better endocrine hormone regulation than physical exercise alone.

Strengths and Limitations:

According to our knowledge, this is the first study to compare how UC and EA affect sex hormones in infertile, obese PCO women. Also, additional strengthening points of this research include the randomized design, the objective evaluative measures, and the therapeutic approaches offered by skilled physiotherapists.

Nevertheless, this study had certain limitations, such as the fact that the patients' psychological and physical health may have affected the evaluation and treatment results, and the fact that environmental conditions might have affected the patients' responses. Also, this study evaluated ovulation rate by measuring serum progesterone level without following up the changes in follicle size by using ultrasonography to ensure ovum maturity. Furthermore, this study was conducted without following up upcoming patients' pregnancy rates as a response to treatment procedures. So, further studies are needed to investigate changes in follicle size through ultrasonography to ensure ovum maturity. Also, the upcoming pregnancy rate as a response to treatment procedures should be followed up in future studies.

CONCLUSION

It could be concluded that both ultrasound cavitation and electroacupuncture are effective in reducing body weight and visceral fat, which are correlated with a more substantial improvement of the hormonal disturbance in obese infertile patients with PCOS.

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Conflict of interest: The authors don't have any conflicts of interest to declare.

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