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Effect of Ultrasound Fat Cavitation as a Complementary Modality to Weight Loss in Egyptian Women with Polycystic Ovarian Syndrome and Abdominal Obesity

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ABSTRACT

The main objective of this study is to assess the role of cavitation as a complementary therapy to weight reduction in women with Polycystic Ovarian Syndrome (PCOS) and abdominal obesity. Sixty Egyptian women with abdominal obesity and PCOS were randomly divided into two groups. Both groups consumed hypo- caloric diet and performed physical exercise for 6 months in aim to lose at least seven % of their body weight. In addition women in the second group underwent ultrasound fat cavitation to the abdomen once weekly. Total testosterone, fasting insulin, ovulation and regularity of menstrual cycles were assessed before and after treatment for both groups. The results showed that the participants in the second group had higher rates of regular menstrual cycles (83.3% vs 60%, P>0.05), higher rates of ovulation (76.6% vs 50%, P>0.05), lower levels of fasting insulin (12.4 ± 3.2 vs 15.3 ± 3.9, P>0.01) and lower serum total testosterone levels (46.8 ± 4.7 vs53.5 ± 5.4, P>0.001) compared to women in the first group. Ultrasound cavitation is considered as a safe and effective adjuvant to weight loss for Egyptian women with polycystic ovarian syndrome and abdominal obesity and it is associated with higher incidence of ovulation and regular menstrual cycles.

Keywords: Polycystic ovarian, Obesity, Ultrasound cavitation, Hypo-caloric diet

INTRODUCTION

Polycystic Ovarian Syndrome (PCOS) is a hormonal disorder result in reproductive problem characterized by increase in androgen male sex hormone blood level. Although all women secrete minimal amount of androgens, too much of this hormone prevents ovulation, with signs of hyperandrogenism (like hirsutism, androgenic alopecia, or acne), chronic oligo- or anovulation with pelvic ultrasound evaluation revealing polycystic ovaries [1].

PCOS is the major endocrine disorder affecting females in age of reproduction and is considered to be the most common cause of an ovulatory infertility. According to diagnostic criteria, PCOS affects 12-21% of women in child bearing period of life; however, many cases are undiagnosed [2]. 75-100% of women with anovulation caused by PCOS have menstrual irregularities, specifically amenorrhea or oligomenorrhea, and this is presented with clinical and/or biochemical proof of hyperandrogenism [3]. PCOS has cardiovascular, psychological, reproductive and metabolic morbidity such as high risk of obesity, type 2 diabetes and other metabolic abnormalities [4]. A lot of researches have shown that disturbance of mental health is linked to PCOS, including anxiety, depression and low life quality [5-7].

Despite prevalence of PCOS and its negative health implications, the etiology and optimal therapies for PCOS remain unclear [8]. A new meta-analysis has shown an elevated prevalence of obesity for women with PCOS compared with controls [9]. PCOS and weight gain show a bidirectional effect where PCOS leads to weight increase and on the other hand, weight gain causes increased incidence and severity of PCOS [10]. Abdominal or central obesity has a leading role in PCOS pathophysiology [11]. Accumulation of fat among obese women with PCOS increases incidence of Insulin Resistance (IR) which is the main cause of several medical complications. In PCOS, adipose tissue has unusual function and morphology [12]. However, there is a little information on the effect of Subcutaneous Adipose Tissue (SAT) on hormonal disturbances and metabolic in PCOS. Abdominal obesity means excessive abdominal fat around the umbilicus. Waist and hip measurements must be taken in order to accurately measure obesity rather than just visually inspecting of naked body (reference of female measurements: minimal waist circumference >88 cm and waist-hip ratio >0.85) [13].

Ultrasound cavitation (UC) (also known as fat cavitation or lipo cavitation) is the method in handling SAT, especially in destroying subcutaneous fat and shaping a particular part of the body. As one of the non-surgical correction method, UC is preferred for lowering the risk of complications due to obesity [14]. The suitable parameter of the UC is 20-70 kHz ultrasound energy that will be emitted at certain depth in a convergent way and focused at a certain point to produce unlimited small vacuum bubbles (fat bubbling). These bubbles are compressed to break the bonds among fat cells, and destroy their membranes to form "cavitation's" (holes in the fat layer) then drain them via lymphatic vessels to be excreted from the body [15]. Studies have proven that ultrasound is characterized as a safe, noninvasive, reliable and predictable ways for body sculpting [16]. Despite that, a lot studies claim to produce statistically significant results, the clinical benefits of ultrasound has yet to be approved [17].

Therapeutic strategies in PCOS include diet-induced weight loss, exercise and medical therapy fail to optimally treat PCOS and all of these can reduce but not reverse IR [18]. Because of its adipocytes property that described above, cavitation ultrasound is supposed to correct the negative impacts of abdominal adipose tissues on the ovarian function and clinical manifestations in women with PCOS and abdominal obesity. Therefore, this study aimed to assess the impact of ultrasound cavitation as a complementary therapy to weight reduction in females with PCOS and abdominal obesity.

MATERIALS AND METHODS

In this study, sixty female patients were recruited from the attendants at outpatient clinic of obstetrics and gynecology department of Al-Azhar University Hospital, Cairo, Egypt. Participants' ages ranged between 18 and 40 y, body mass index equal to or greater than 25 kg/m^2, WC>88 cm, WHR>0.85 and had PCOS. Diagnosis of PCOS was confirmed according to the modified Rotterdam criteria [19] and all subjects had anovulation plus either ultrasound evidence of polycystic ovaries (presence of ≥12 antral follicles ≤9 mm and/or ovarian volume >10 ml on transvaginal scanning) or clinical hyperandrogenism (modified Ferriman-Gallwey score of ≥6, presence of acne or seborrhea) and/or biochemical evidence of hyperandrogenemia. Menstrual disorders defined as oligomenorrhea (cycle length >35 days) or amenorrhea (cycle length >12 weeks).

Exclusion criteria included: diabetes mellitus, hyperprolactinemia, thyroid disorders, late-onset congenital adrenal hyperplasia, Cushing's syndrome, liver or kidney diseases and current pregnancy. As such, all participants underwent hormonal profile, oral glucose tolerance test and ACTH-stimulation test to exclude secondary causes of hyperandrogenism and manifest diabetes. Participants who failed to lose>7% of pretreatment body weight were excluded from the study. None of the participants had taken hormonal contraceptives; medications that affect gastrointestinal motility or carbohydrate metabolism for at least 2 months prior to study begin such as insulin sensitizers, insulin, anti-epileptics, H_2-blockers, cholesterol-lowering drugs and diuretics.

All women underwent physical examination, blood sampling for hormone assay**,** assessment of modified Ferriman-Gallwey (mFG) score [20], anthropometric parameters measurements (height, weight, waist and the hip circumferences). Waist Circumference (WC) was measured at the narrowest portion of the torso approximately midway between the lower costal margin and the iliac crest, and the hip circumference was measured over the widest portion of the gluteal and greater trochanteric region. The BMI and WHR were then calculated.

Blood samples were withdrawn from all women (fasted) before and after they were underwent to the study program. Blood samples were centrifuged and the sera were separated into aliquots and preserved at minus 80°C till the hormonal, Luteinizing Hormone (LH), Follicle-stimulating Hormone (FSH), Insulin and testosterone, measurements as fast as possible. All the hormonal assays were carried out using Enzyme Linked Immunosorbent Assay (ELISA) technique. Serum LH was determined using human LH ELISA kits (Cat No 11-LUTHU-E01) purchased from ALPCO, USA; Follicle stimulating hormone was estimated using human FSH ELISA kit (Cat No PT FSH 48) purchased from Pishtaz Teb Diagnostics, Germany; Fasting insulin level was measured using human insulin ELISA Kit (Cat No KAQ1251) purchased from AssayPro, USA; while testosterone hormone was determined using human ELISA Kit (Cat No ab178655) purchased from ABCAM, Cambridge, UK.

Participants were randomly divided into two groups (group I and group II). Each group included 30 women. Participants were randomized for this study in a 1:1 allocation ratio using a computer-generated random number table. All participants underwent a combined intervention of diet and exercise with the goal of achieving an average weight loss of at least 7% from initial body weight over 6 months, with a prescription of 150 min/week of exercise combined with a balanced hypocaloric diet that provided 1500-1800 kcal daily according to the requirement of each subjects. Caloric needs were calculated by Harris Benedict equation as follow: Females: BEE=65.5+9.6 (weight in Kg) +1.7 (height in cm) –4.7 (age) [21], then we subtracted 500 calories from calculated energy requirement.

The menu varied according to the participant's age and eating habits. It was low in fat (20%-25%), high in complex carbohydrate (50%-60%), and sufficient in protein (25%-30%). Carbohydrate consumed as complex CHO which have low glycemic load and index as whole grains, oat, fresh seasonal fruits and vegetables to consume high fiber content. In the other hand, they were informed to decrease foods rich in saturated fats as fried foods and bagged meats. Protein was intake from animal and vegetarian sources. No vitamins or other nutritional supplements were prescribed.

In addition to the hypocaloric diet, women in group II were treated locally by low frequency cavitation ultrasound to anterior abdominal wall one session per week for 30 min (37 Kz, 2.5 watt/cm^2) (Megason model, Medical Vision Company, Korea) for 24 sessions. Then the probe was applied over the site of lymphatic drainage of treated areas for 10 min to open the main lymph nodes to facilitate the flow and the removal of excess fluids that lead to natural elimination of the fat waste. All participants signed an informed consent form after receiving an explanation about the study.

RESULTS

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) version 21 was used for data analysis. All data were expressed as mean ± SD unless otherwise stated. Independent-samples t tests or Mann-Whitney U tests were used as appropriate for comparison between two groups as well as to compare groups before and after intervention. P>0.05 was accepted as statistically significant (Tables 1-5).

Table 1: Basic characteristic of both groups

Characteristic	Group I (n=30)	Group II (n=30)	P value
Age (years)	26.3 ± 4.8	25.6 ± 5.1	(>0.05) NS
Weight (kg)	91.8 ± 14.6	92.2 ± 14.8	(>0.05) NS
Height (cm)	163.3 ± 6.7	162.5 ± 6.3	(>0.05) NS
BMI (kg/m²)	32.9 ± 3.1	33.3 ± 3.2	(>0.05) NS
WHR	0.89.2 ± 4.1	0.88 ± 3.7	(>0.05) NS
Menstrual pattern			
Regular cycles	0	0	(>0.05) NS
Oligomenorrhea	17 (56.6%)	19 (63.3%)	(>0.05) NS
Amenorrhea	13 (43.3%)	11 (36.6%)	(>0.05) NS
Hormonal profile			
LH (mIU/ml)	10.3 ± 2.5	10.5 ± 2.3	(>0.05) NS
FSH (mIU/ml)	5.4 ± 1.7	5.3 ± 1.5	(>0.05) NS
LH/FSH ratio	1.9 ± 0.6	1.8 ± 0.5	(>0.05) NS
Fasting insulin (uU/ml)	23.8 ± 6.7	24.1 ± 5.8	(>0.05) NS
Total testosterone (ng/dl)	88.7 ± 6.3	87.8 ± 5.7	(>0.05) NS

Data were expressed as mean± standard deviation; number (%); NS: Non-Significant;
BMI: Body Mass Index; WHR: Waist Hip Ratio; LH: Luteinizing Hormone; FSH: Follicle Stimulating Hormone

Table 2: BMI and WHR after treatment for both groups

Variable	Group I (n=30)	Group II (n=30)	P value
BMI (kg/m²)	26.7 ± 2.70	27.2 ± 2.50	(>0.05) NS
WHR cm/cm	0.85 ± 0.02	0.79 ± 0.01	(<0.001) S

BMI: Body Mass Index; WHR: Waist Hip Ratio

Table 3: Menstrual pattern after treatment for both groups

Menstrual pattern	Group I (n=30) n (%)	Group II (n=30) n (%)	P value
Regular cycles	18 (60%)	25 (83.3%)	(<0.05) S
Oligomenorrhea	8 (26.6%)	3 (10%)	(>0.05) NS
Amenorrhea	3 (10%)	2 (6.6%)	(>0.05) NS

S: Significant; NS: Non-Significant

Table 4: Hormonal profile after treatment for both groups

Variable	Group I (n=30)	Group II (n=30)	P value
LH (mIU/ml)	7.5 ± 2.4	6.9 ± 1.9	> 0.05 NS
FSH (mIU/ml)	5.2 ± 1.3	5.1 ± 1.2	> 0.05 NS
LH/FSH (ratio)	1.2 ± 0.5	1.1 ± 0.4	> 0.05 NS
Fasting insulin (uU/ml)	15.3 ± 3.9	12.4 ± 3.2	< 0.01 S
Total testosterone (ng/dl)	53.5 ± 5.4	46.8 ± 4.7	< 0.001 S

Data are expressed as mean ± standard deviation; S: Significant; NS: Non-Significant

Table 5: Ovulation and follicular growth after treatment for both groups

Variable	Group I (n= 30)	Group II (n= 30)	*P* value
Ovulation [n (%)]	15 (50%)	23 (76.6%)	< 0.05
Follicular growth factor	19.7 ± 3.1	21.4 ± 3.3	> 0.05 NS

Data were expressed as mean ± standard deviation; S: Significant; NS: Non-Significant

DISCUSSION

This study had demonstrated that application of cavitation ultrasound as complementary modality to weight loss for women with d polycystic ovarian syndrome and abdominal obesity was associated with higher rates of ovulation (76.6% vs 50%, P>0.05), higher rate of regular menstrual cycles (83.3% vs. 60%, P>0.05), lower levels of fasting insulin (12.4 ± 3.2 vs. 15.3 ± 3.9, P>0.01) and total testosterone (46.8 ± 4.7 vs. 53.5 ± 5.4, P>0.001).

It is well established that dietary weight loss with or without exercise in women with PCOS resulted in significant improvement in ovarian function and menstrual regularity [22-24]. There is still a controversy in the pathogenic role of obesity and body fat distribution in PCOS. Current data supported the idea that PCOS and abdominal obesity may have a synergistic negative effect on insulin sensitivity [25]. IR and compensatory hyperinsulinemia have a unique role in the pathogenesis of PCOS [26]. Previous studies had pointed to the relation between PCOS and compromised insulin action; those studies had described IR as an integral feature of PCOS. However, underlying mechanisms of IR remained ill-defined [8]. In addition to that, others had discovered that in case of absence of high abdominal adipose tissue, females with POCS may not be insulin resistance. IR may cause hyperandrogenism through different mechanisms such as a direct stimulation of ovary, central action (pituitary), or by a hepatic action with a decreased production of Insulin-like Growth Factor Binding Protein-1 (IGFBP-1) and Steroid Hormone-binding Globulin (SHBG). These discoveries have a great role in the pathophysiology of obesity development and management in PCOS [27]. Obesity is known to accentuate IR and worsen the situation in PCOS. Moreover, in obese patients, the concentration of insulin receptors per adipocyte is reduced [28]. In obese patients with PCOS there is an additional mechanism in the form of exacerbation of hyperandrogenism. Hyperandrogenism drives arrest of ovarian folliculogenesis leading to anovulation and menstrual disturbance [29]. Therefore, insulin-sensitizing agents had been studied in the management of PCOS. These mechanisms were supported by many studies reported that, in females, excess of abdominal adiposity had been associated with insulin resistance and hyperandrogenism [30-32].

From other hand, many published studies reported that PCOS patients with increased abdominal fat had significantly higher insulin levels and significantly reduced insulin sensitivity than controls with similar quantities of abdominal fat and improvement in hyperandrogenemia was associated with improvement of menstrual cycle, metabolic and endocrine parameters in women with PCOS [22,33-35]

Our study agree with Hanan and Hassan [22] who suggested that PCOS women with obesity who treated with cavitation in addition to exercise and low caloric diet were associated with a more significant correction of the hormonal level and improvement of menstrual abnormalities as well as increased the ovulation compared to patients with only low caloric diet with exercises only. Many studies reported the efficacy and safety of cavitation in reducing visceral adipose tissues and abdominal subcutaneous like these several previous studies [36-39] investigated that the effect of UC on 30 healthy patients who received 3 treatments, at 1-month intervals by UC then after their last treatment they were followed for 1 month. All patients showed a great decrease in fat thickness of subcutaneous tissue within the treated area. After three treatments the mean reduction in fat thickness was 2.28 ± 0.80 cm also WC had a mean decrease of 3.95 ± 1.99 cm. Other studies had revealed the efficacy and safety of UC for fat reduction in the abdomen and the flanks. These studies indicated consistent reduction in abdominal circumference>2 cm after a single treatment [40-42].

While following hypocaloric diet, women with the abdominal obesity phenotype respond better than those with peripheral type. That is why; weight loss is expected to be more in case of combining UC with a hypocaloric diet. Also, UC reported a greater decrease of the WHR, suggesting a valuable modification of fate distribution pattern, especially at the abdominal level. This reduction in regional fat distribution could contribute to the effect of cavitation in improving the hormonal profiles in obese women with PCOS [22].

The nature of cavitation ultrasound therapy had prevented blinding in the study. The relatively small sample size of participants represented another limitation of this study. Upcoming clinical studies with larger number of subjects are encouraged to measure the effects of cavitation ultrasound more accurately and to test its therapeutic effect in PCOS.

CONCLUSION

Cavitation ultrasound is effective and safe complementary modality for weight loss for women with polycystic ovarian syndrome and abdominal obesity as it is associated with higher rates of ovulation, higher incidence of regular menstrual cycles, and lower levels of total testosterone and fasting insulin

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