Effect of Diet, Exercise and Electrolipolysis on Hormonal Changes in Obese Women Having Polycystic Ovarian Syndrome

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ABSTRACT

This study had been carried out on 60 obese patients with proved polycystic ovarian syndrome (PCOS) with body mass index (BMI) >32 kg /m^2 in an attempt for determining the effect of hypocaloric diet alone or as well as with exercise program or electroliopolysis on hormonal changes Luteinizing hormone (LH), Follicular stimulating hormone (FSH), (LH/FSH), fasting insulin and sex hormone binding globulin (SHBG), ovulation and pregnancy rate .All patients assigned randomly into three equal groups: Group (A) treated by diet and exercises program, Group (B) treated by diet and electroliopolysis and Group(C) treated by diet only. All patients received the previous treatment for four months and followed a hypocaloric dietary regimen of 1200 kcal / day. Results showed significant changes in the hormonal profiles, ovulation and pregnancy rate between before and after the end of treatment periods in both groups (A) and (B), while group (C) were non-significantly. Also, there was a detectable significant difference between the three groups after the end of the treatment with favor improvement in group (B) than the other groups. Which represented that electroliopolysis is more effective in treating obese women with PCOS.

Key words: *obesity, polycystic ovarian syndrome, electroliopolysis, exercise, diet.*

INTRODUCTION

Polycystic ovarian syndrome (PCOS) is a common endocrine and metabolic disorder that occurs in 6-10% of women at the reproductive age[3,17]. It is associated with anovulation, infertility, hyperandrogenism, obesity and insulin resistance[20]. Endocrine characteristics of PCOS are elevated serum concentrations of androgens and Luteinizing hormone (LH) and decreased concentrations of sex hormone binding globulin (SHBG). The anovulation is associated with disturbance in the feedback from ovarian steroid hormones to the hypothalamus and pituitary, resulting in disturbances of the pulsatility of gonadotropin releasing hormone release (GnRH)[3,29].

Obese women with PCOS have a characteristic distribution of a central pattern of body fat known as android obesity in which fat deposited in the abdominal wall and visceral mesenteric area. This fat is more sensitive to catecholamines and less sensitive to insulin[25]. In addition women with higher waist/hip ratios (i.e. more abdominal relative

to hip fat) have higher total androgen and lower SHBG levels[26]. The increased androgen levels may directly affect insulin sensitivity in the target tissues, particularly the muscles, therefore contributing to the development of the insulin resistance state[1]. Obese women with PCOS need some long standing treatment to diminish their increased risk for endometrial cancer[24], hypertension and type II diabetes[20].

In obese PCOS women, the first line of therapeutic option prior to any chemical treatment for induction of ovulation is weight loss[10] which helps to correct the clinical and endocrine abnormalities[28]. Weight loss is encouraged to ameliorate the metabolic consequences of PCOS, to improve spontaneous ovulation and to reduce the risk of spontaneous abortions following ovulation induction[1]. So many authors have recommended low caloric diet[13], exercise[19] and anti diabetic drugs[27] as effective modalities for inducing weight loss in obese PCOS women.

Transpercutaneous electric abdominal muscle stimulator for one month can significantly reduced body weight and intra abdominal visceral fat in obese hypertensive women[31].

So varieties of methods were reported to induce weight loss in obese PCOS women. But lack of comparative studies on the effect of diet alone and combined with either exercise or electrolipolysis necessitated the need for more comparative research in an attempt to reach to the most appropriate method for inducing weight loss and hormonal changes in obese PCOS women.

The current study was designed to determine the ideal method that should be used for weight loss by comparing the effect of diet alone or combined with either exercises or electrolipolysis on the hormonal changes (LH, FSH, LH/FSH, fasting insulin and SHBG) and ovulation as well as pregnancy rate in obese women with PCOS.

SUBJECTS, MATERIALS AND METHODS

Subjects

Sixty obese women with body mass index (BMI) >32Kg/m^2, abdominal body fat distribution defined by waist/hip ratio >0.80 and they were between the ages of 23 and 31 years (mean 28.6 ± 1.3 years), were recruited in this study from the infertility unit, outpatient clinic at Ain Shamas University Hospital.

Inclusion criteria were amenorrhea (no menses in the last 6 months) or oligomenorrhea (Less than four cycles in the last 6 months) and a typical ultrasonographic presentation of PCOS (multiple subcapsular follicles and thickened ovarian stroma) as well as biochemical data as high androgens and LH / FSH ratio > 1.5[20].

In addition all women were free from any medical disorders as diabetes mellitus, thyroid dysfunction or concomitant cardiovascular, respiratory, renal and liver dysfunction.

Patients with tubal adhesions as well as uterine abnormalities were excluded from the study and had not taken any hormonal treatment for at least 3 months prior to the start of the study or throughout the entire study period.

They were randomly divided into three equal groups: group (A) participated in the exercise training program, group (B) received electrolipolysis on the abdomen and gluteal region and group (C) served as control group. All the three groups followed the same hypocaloric diet of 1200 kcal/day for four months. Informed consent form had signed by each patient in this study. Women who

conceived during the study were terminated their participation.

Instrumentation

1- Weight-height scale for measuring the weight and height, then calculate the BMI in all groups.
2- Body Program Slimmy (Model number IGC 601-1) with 8 channels used for the application of electrolipolysis in group (B).
3- Stationary bicycle ergometer (Model number E4.5) used for performing aerobic training in group (A).
4- Ultrasonic machine (Medicine 8800 Gia MT) was used for measuring the follicular growth and ovulation.

Procedures

a- Evaluative procedures

Initially a careful history was taken from each woman then the following evaluations were done in the three groups.

- BMI and waist/hip ratio.

Measurements of BMI in which the weight in kilograms divided by the square of the heights in meters and waist to hip circumference measured with a soft tape at the level of the umbilicus and the anterior superior iliac spine with woman in the standing position, were made before treatment and after the end of the study period (4 months).

- Biochemical assays

Blood samples were drown from an antecubital vein of each patient in the study at two occasions, firstly at 2^{nd} or 3^{rd} day of the menstrual cycle after an overnight fasting just before starting her treatment regimen and secondly after 4 months of the treatment. It was centrifuged within 2 hours after withdrawal. Serum was stored at $-20^{O}C$ and assayed for LH and FSH with chemiluminescent enzyme immunoassay kits. Assays for fasting insulin by RIA kits and SHBG was determined by using an immunoradiometric assay (IRMA).

- Ovulation and follicular growth

It was done before and after the end of the treatment period in the three groups through abdominal sonographic examination with full bladder.

b- Treatment procedures

All patients in the three groups were followed the same hypocaloric diet of 1200 kcal/day for four months that contains high protein 50%, carbohydrate 30% and low lipid 20% as mentioned by Moran et al.,[22].

1- Exercise training program (Group A).

Each patient was participated in an exercise training program, three sessions per week for four months. Each exercise session was consisted of two programs of exercise training:

I- Program of aerobic training for 30 minutes on a bicycle ergometer in which five minutes of warm up in the form of pedaling at 60 revolution per minute without load, twenty minutes of active pedaling with adjusted load to achieve 60% of the patient predictive age of maximal heart rate (Maximal heart rate = 200- age of woman in years)[21] and ended the aerobic training session by five minutes of cool down as in warm up.

II- The other training program was specific for the gluteal and abdominal regions. In which exercise was performed for training the gluteus maximus muscles by making hyper extension of the right hip then left hip (back straight leg raising exercise) from prone lying position as well as standing against wall bars. Then the gluteus meduis muscles were exercised by making abduction of

the hip joint from supine, side lying and standing position. The abdominal muscles were exercised by performing trunk sit ups (Crunches), lateral bends and rotation. Sustained muscle contraction for each specific exercise was maintained for 5 seconds followed by 10 seconds of relaxation. Each patient performed two sets of 10 repetitions per session for each specific exercise.

2- Electrolipolysis (Group B).

Before starting treatment session each patient was asked to evacuate her bladder to make sure that she was comfortable and relaxed. Then the woman lied in supine lying position. The electrodes of the 1st and 2nd channels were placed just above and below umbilicus by 5cm on right and left side. The electrodes of the 3rd and 4th channels were placed just below inguinal ligament and on the most raised area of the quadriceps muscle on both body sides. The gluteal region was stimulated, in which the electrodes of the 5th and 6th channels were placed on either sides of the sacrum and on the most raised area of the buttocks on right and left side. The electrodes of the 7th and 8th channels were placed on either sides of the greater trochanter and on the mid point of the thigh on both body sides.

Then treatment started with contraction time for four seconds followed by another four seconds of relaxation time, the machine adjusted at 20 pulses/ minute and its pulse width was at 400 microseconds. The machine was automatically switched off when the session time ended (60minutes).

c- Statistical analysis

Data were collected and statistically analyzed using the arithmetic mean, standard deviation and student t test between before and after four months of treatment in each group. Also, one way ANOVA test was used to compare between all groups before and after treatment. A P value of <0.05 was accepted as statistically significant.

RESULTS

At baseline, woman with PCOS in the three groups were of similar age and primary infertility presented in 12, 14 & 10 cases in group (A), (B) and (C) respectively and the remainder of them had secondary infertility.

BMI and waist/hip ratio are presented in table (1). Before treatment, there was no difference between the three groups while, after treatment BMI showed a statistically reduction in group (A & B) but didn't in group (C). Whereas waist/hip ratio was significantly decreased after treatment only in group (B), on the contrary other groups did not change significantly. In addition comparison between the three groups revealed a significant difference (F=3.56, P<0.05) with favor major reduction in BMI and waist/hip ratio in group (B) than others.

Table (1): BMI and waist / hip ratio of all groups.

Variables		Group (A) (Exercise & diet)		Group (B) (Electrolipolysis & diet)		Group (C) (Diet)	
		Pre Treatment	Post Treatment	Pre Treatment	Post Treatment	Pre Treatment	Post Treatment
BMI (Kg/m^2)	**Mean**	33.76±2.51	29.21±2.91	32.10±2.39	28.72±2.22	32.62±2.02	30.62±2.73
	P Value	< 0.05		< 0.05		> 0.05	
Waist/ hip ratio	**Mean**	88.98±2.83	86.97±5.05	88.01±3.91	85.7±4.91	87.97±3.62	87.01±5.41
	P Value	> 0.05		< 0.05		>0.05	

After completion of the treatment period about 70% of women resumed their regular menstruation in group (B) and 60% in group (A) and the lowest number was in group (C) 30%. The regular menstruation was significant increased in group (A), (B) and (C) between before and after treatment with favorite improvement in group (B) than other groups, Table (2) and Fig. (1).

Table (2): Menstrual pattern before and after treatment in all groups.

Groups	Menstrual	Pre treatment (Number of women)	Post treatment (Number of women)	P value
Group (A) (Exercise & diet)	**Regular**	2 (10%)	12 (60%)	< 0.05
	Oligomenorrhea	11 (55%)	6 (30%)	
	Amenorrhea	7 (35%)	2 (10%)	
Group (B) (Electroliplysis & diet)	**Regular**	3 (15%)	14 (70%)	< 0.01
	Oligomenorrhea	9 (45%)	4 (20%)	
	Amenorrhea	8 (40%)	2 (10%)	
Group (C) (Diet)	**Regular**	2 (10%)	6 (30%)	< 0.05
	Oligomenorrhea	10 (50%)	11 (55%)	
	Amenorrhea	8 (40%)	3 (20%)	

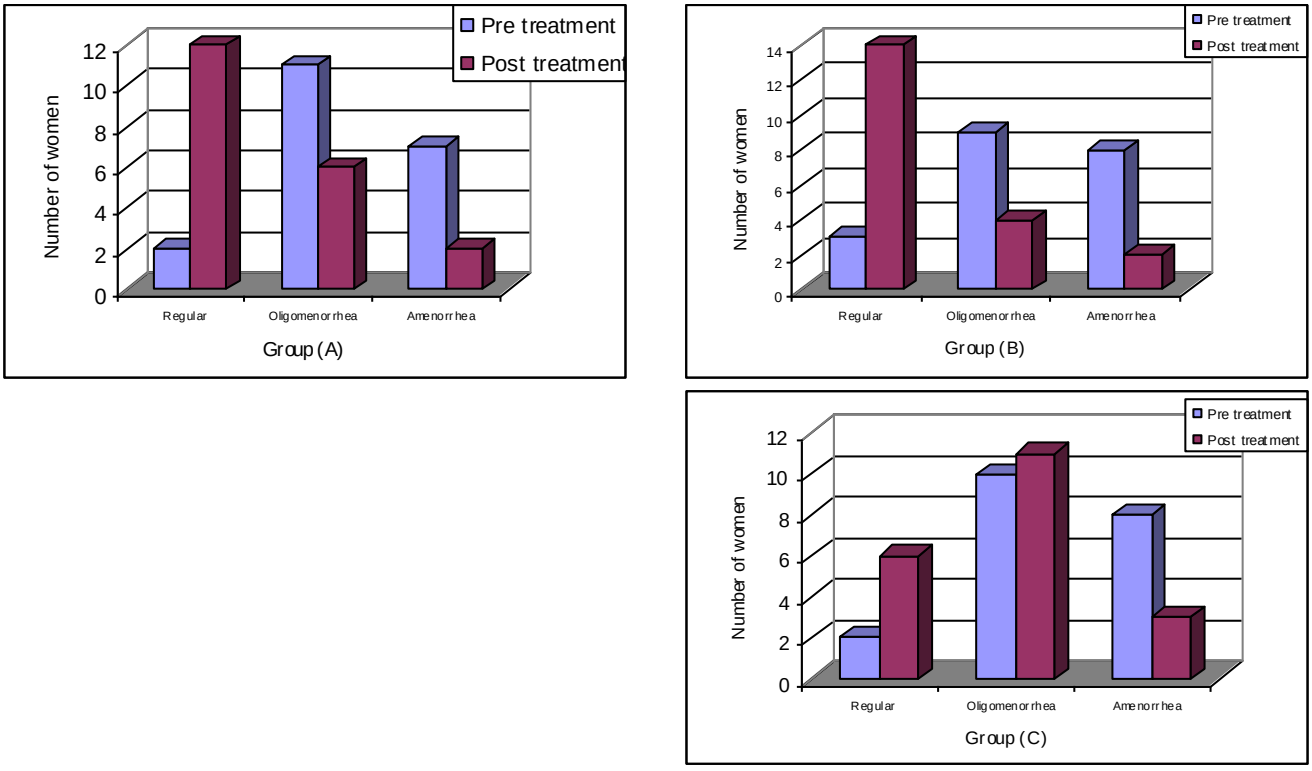

Fig. (1): Menstrual pattern of all groups.

Before treatment, the mean fasting insulin levels, LH, and LH/FSH ratio tends to be higher than normal limits and FSH & SHBG was lower than normal limits but without any significant difference between the three groups. As a result of the treatment methods, there was a significant reduction in LH, LH/FSH ratio and fasting insulin and increase in FSH and SHBG in group (A & B), whereas no significant change was found in group (C). The most changes in hormones were presented in group (B) than in group (A) after completion of the treatment, Table (3).

Table (3): Hormonal profile in the three groups before and after treatment.

Variables	Groups	Pre treatment	Post treatment	P value
LH (mIU/ ml)	(A)	9.4 ± 2.6	7.6 ± 2.3	< 0.05
	(B)	9.7 ± 2.2	7.1 ± 2.1	< 0.01
	(C)	8.8 ± 2.1	8.2 ± 3.9	> 0.05
FSH (mIU/ ml)	(A)	5.3 ± 1.6	6.2 ± 1.5	< 0.05
	(B)	5.2 ± 1.3	6.6 ± 1.2	< 0.05
	(C)	5.1 ± 1.4	5.4 ± 1.67	> 0.05
LH/ FSH ratio	(A)	1.8 ± 0.7	1.2 ± 0.6	< 0.05
	(B)	1.9 ± 0.5	1.07 ± 0.3	< 0.01
	(C)	1.7 ± 0.9	1.5 ± 0.4	> 0.05
Fasting Insulin (µU/ ml)	(A)	19.5 ± 6.8	15.2 ± 5.3	< 0.05
	(B)	19.8 ± 5.7	15.1 ± 6.1	< 0.01
	(C)	19.1 ± 6.5	18.5 ± 5.7	> 0.05
SHBG (ng/ ml)	(A)	3.4 ± 1.2	3.9 ± 2.1	< 0.05
	(B)	3.3 ± 1.1	4.2 ± 1.9	< 0.05
	(C)	3.2 ± 1.3	3.5 ± 1.2	> 0.05

As a result of the weight loss program and its effects for improving the hormonal profiles specially in group (B) than (A) and (C), the number of women regained their normal ovulation and optimal follicular growth was 10, 13 and 4 women in group (A), (B) and (C) respectively after the end of treatment as well as the occurrence of pregnancy was more in group (B) 5 cases than group (A) 3 cases and the lowest conception was found in group (C) only one case, Table (4) and Fig. (2).

The comparison between groups showed a statistically significant ($P<0.05$) increase in the number of women who had normal ovulation and follicular growth as well as increased pregnancy rate in group (B) than other groups.

Table (4): Ovulation, follicular maturity and pregnancy rate after treatment.

Groups	Ovulation (Number of women)	Follicular growth (mm)	Pregnancy rate (Numbers)
Group (A)	10 (50%)	19.9 + 3.2	3 (15%)
Group (B)	13 (65%)	21.2 + 3.3	5 (25%)
Group (C)	4 (20%)	18.1 + 2.9	1 (5%)
P value	< 0.01	< 0.001	< 0.05

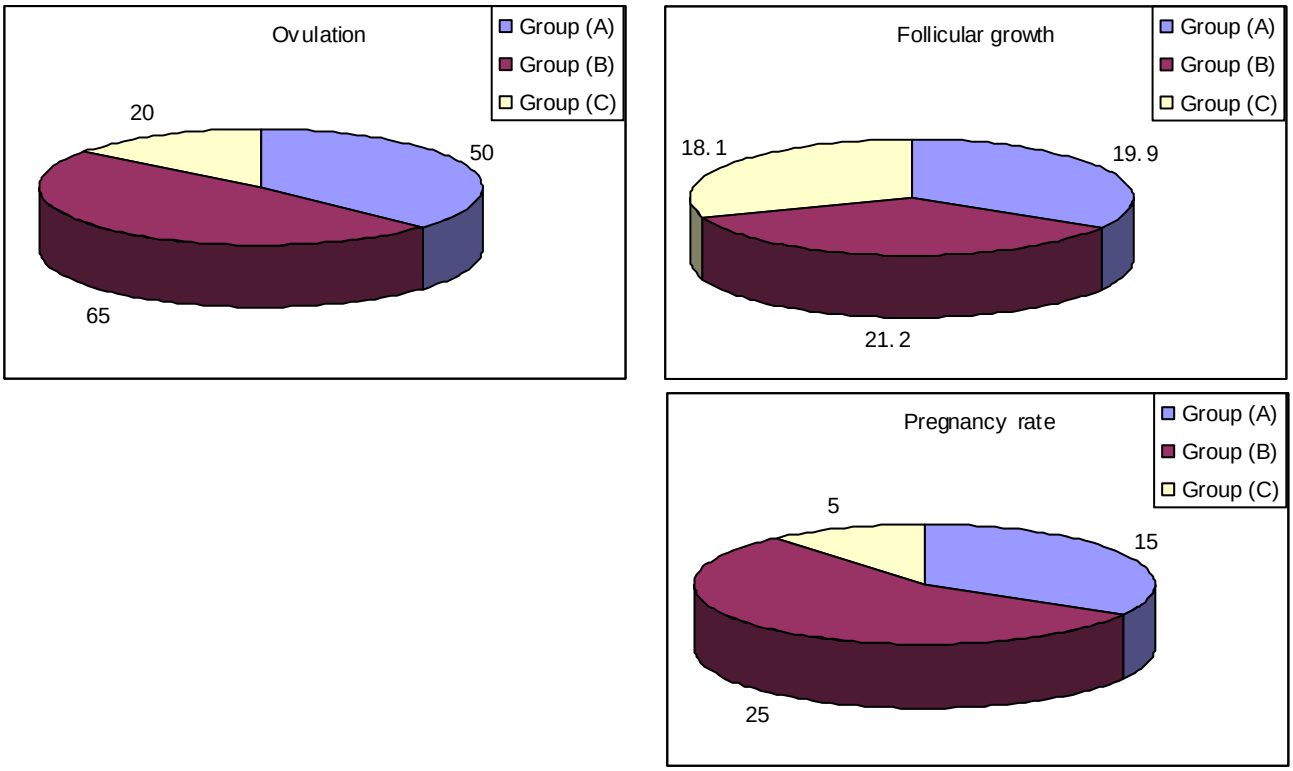

Fig. (2): Ovulation, follicular growth and pregnancy rate in the three groups after the end of the treatment program.

DISCUSSION

This study was conducted to determine whether body weight and fat distribution changes via hypocaloric diet alone as well as with exercise or electrolipolysis could affect the hormonal profiles, ovulation and hence pregnancy rate in obese women with PCOS.

The results of the present study proved that hypochloric diet with exercise or electrolipolysis produced a significant reduction in body weight and visceral fat which changes significantly all the abnormal hormones by reducing fasting insulin, LH and LH/ FSH ratio and increasing FSH as well as SHBG, ovulation and pregnancy rate in obese women with PCOS after 4 months of treatment, which indicated that hypocaloric diet with other methods of weight reduction have a good effect in treating obese women with PCOS than when used alone. Also, it represented that electrolipolysis was an effective method in treating such cases. These results appear to justify the opinions regarding the effectiveness described in the study of Tochikubo et al., (1994)[31] who used transpercutaneous electric abdominal muscle stimulation (3000 muscle contractions / day) for four weeks to treat obese subjects, those subjects showed significant reduction in body weight and intra abdominal visceral fat.

Also, Joseph (1987)[14] reported that when a muscle contracts as a result of electrical stimulation, the chemical changes taking place within the muscles are similar to those associated with voluntary contractions in normal exercising. These chemical reactions which results from muscle contractions utilize

glycogen fat and other nutrients stored in the muscles. Also, it enhances energy consumption, carbohydrate oxidation and whole body glucose uptake[8]. Other explanation about the effect of electrolipolysis was mentioned by Kanter and Alon, (1994)[15] who reported that electrical stimulation stimulates the adrenergic interstitial nerve endings that liberates more catecholamine hormone which enhance the adenilate cyclase to convert adenosine triphosphate to cyclic adenosine monophsphate thus activating lipasis.

Unfortunately any further comparison regarding the effects of electrolipolysis on weight loss in PCOS is difficult because there are no studies curried out.

So that, during hypocaloric dieting women with the abdominal obesity phenotype respond better than those with peripheral type[5], it could have been expected that when electrolipolysis is combined with a hypocaloric diet, the weight loss could be greater. In addition electrolipolysis favored a greater reduction of the waist/ hip ratio, which suggest a significant modification of the pattern fat distribution, particularly at the abdominal level. This reduction in regional fat distribution could contribute to the positive effect of electrolipolysis in improving the hormonal profiles in obese women with PCOS.

In the present study moderate caloric diet (1200 kcal/ day) did not significantly improve the hormonal profile as well as pregnancy rate (5%) in obese PCOS, that did not come inconsistent with the study of Kiddy and his colleague (1992)[16] who reported that 77% of the obese infertile women conceived spontaneously after dieting.

Interestingly in (2000), Butzow et al.,[2] confirmed and agree with that of Harless et al., (1984)[9] in which they concluded that weight reduction with very low caloric diet (500 Kcal/day) in severally over weight infertile women results in a decrease LH concentration, a reduction in LH/ FSH ratio and FSH predominance favoring follicular genesis.

While the combination between low caloric diet with exercise in this study showed an obvious improvement in the hormones with higher pregnancy rate reached 15% which supported by the study of Hollman et al., (1996)[11].

The present results concerning the effect of exercise on the female sex hormones (FSH, LH and LH / FSH ratio) were supported by the work of Hollman et al., (1996)[11] who found that FSH increased with exercise. Also, Huber-Buchholz et al., (1999)[12] reported that exercise program resulted in 39% reduction in LH levels which cause a restoration of ovulation in treated overweight, infertile women.

The results of the present study for exercise agreed with those reported by Kraemer et al., (1999)[18] who demonstrated that aerobic exercise three times / week for 12 weeks results in a significant reduction in body mass and fat mass. In addition Evans et al., (1999)[6] found that aerobic exercise at 50% of maximal oxygen consumption results in weight reduction by a means of 3.9±3.4 Kg and decrease in the percentage of body fat by 2.5%.

Galletly and his colleague (1996)[7] mentioned that program of a regular exercise and group discussion of topics such as coping with the psychological impact of infertility, developing healthy eating patterns and the effect of obesity on the reproductive physiology can produce considerable improvement in the outcome of treatment for infertility in obese women.

Aerobic exercise training modifies adipose tissue lipolysis through enhancement

of ∝-adrenergic response and decrease in the adipocyte antilipolytic activity and reduced fasting insulin concentration[4]. Also, the addition of exercise to hypocaloric diet is advocated to counteract the negative metabolic adaptations that occur during caloric restriction because exercise prevents declines in fat oxidation[23].

Locus et al., (1998)[19] reported that the stress of the exercise reduce LH pulse frequency, thus exercise energy expenditure alone can reduce energy availability to suppress LH pulsitility which can be followed by reduced androgen production. On the other hand, in 1997 study of Shangold[30] showed that FSH and LH level are not affected by 30 minutes of intense cycle ergometer exercise.

Conclusion

This study showed that PCOS women with abdominal obesity, who treated with electrolipolysis added to hypocaloric diet, induced a greater reduction of body weight and visceral fat which were associated with a more significant correction of the hormonal and menstrual abnormalities as well as increased occurrence of pregnancy in comparison with exercise added to hypocaloric diet.

REFERENCES

1- Barnes, R.: "Diagnosis and therapy hyperandrogenism", Baillieres Clin Obstet Gynecol, 11(12): 369-386, 1997.

2- Butzow, T., Iehtovirta, M., Siegberg, R., Hovatta, O., Jaistinen, R., Seppala, M. and Apter, D.: "The decrease in Luteinizing hormone secretion in response to weight reduction is inversely related to the severity of insulin resistance in over weight women", J Clin Endocrinol Metab, 85: 3271-3275, 2000.

3- Crosignani, P. and Nicolosi, A.: "Polcystic ovarian disease: heritability and heterogeneity", Hum Reprod Update, 7(1): 3-7, 2001.

4- Deglisezinisk, I., Crampes, F., Harant, I., Berlan, M., Heijnova, J., Longin, D., Riviere, D. and Stick, V.: "Endurance training changes in lipolytic responsiveness of obese adipose tissue", Am J Physiol, 275: E 951- E 956, 1998.

5- Dwyer, J.: Treatment of obesity: Conventional programs and fat diets, In Bjorntorp P.; Brodoff B. (eds.) Obesity 1st ed., J. B. Lippincoll Co., Philadelphia, pp.662-676, 1992.

6- Evans, E., Saunders, M. and Spano, M.: "Effects of diet and exercise on the density and composition of the fat free mass in obese women", Med Sci Sport Exercise, 31(12): 1178-1187, 1999.

7- Galletly, C., Clark, A. and Tomlinson, L.: "Evaluation of dexfenfluramine in a weight loss program for obese infertile women", Int J Eat Disord, 19: 209- 212, 1996.

8- Hamada, T., Hayashi, T., Kimura, T., Nakao, K. and Moritani, T.: "Electrical stimulation of human lower extremities enhances energy consumption, carbohydrate oxidation and whole body glucose uptake", J Appl. Physiol., 95: 911-916, 2003.

9- Harless, F., Plymate, S., Fariss, B. and Belt, S.: "Weight loss is associated with correction of gonadotropin and sex steroid abnormalities in obese anovulatory female", Fertil Steril, 42: 649-652, 1984.

10- Hoeger, K.: "Obesity and weight loss in polycystic ovary syndrome", Obstet Gynecol Clin North Am, 28 (4): 85 97, 2001.

11- Hollman, M., Runnebaum, B. and Gerhard, I.: "Effects of weight loss on the hormonal profile in obese infertile women", Hum Reprod, 11: 1884-1891, 1996.

12- Huber-Buchholz, M., Carey, D. and Norman, R.: "Restoration of reproductive

potential by lifestyle modification in obese polcystic ovary syndrome; role of insulin sensitivity and luteinizing hormone", J Clin Endocrinol Metab, 34(4): 1470-1474, 1999.

13- Jakubowicz, D. and Nestler, J.: "17A hydroxy progesterone response to leuprolide and serum androgens in obese women with and without polycystic ovary syndrome after weight loss", J Clin Enodcrinol Metab, 82: 556-560, 1997.

14- Joseph, K.: Principles and practice of electrotherapy, 3rd ed., Science Press, USA, PP. 96-98, 1987.

15- Kanter, G. and Alon, G.: "The effects of selected stimulus wave forms on sensory and motor nerves", Phys Ther, 74: 951-962, 1994.

16- Kiddy, D., Hamilton-Fairely, O., Bush, A., Short, F., Anyaoku, V. and Reed, M.: "Improvement in endurance and ovarian function during dietary treatment of obese women with polycystic ovarian syndrome", Clin Endocrinol, 36: 105-111, 1992.

17- Koivunen, R., Laatikainen, T., Tomas, C., Huhtaniemi, I., Tapanainen, J. and Marktikainen, H.: "The prevalence of polycystic ovaries in healthy women", Acta Obstet Gynecol Scand, 78: 137-141, 1999.

18- Kraemer, R., Kraemer, G. and Acevedo, E.: "Effects of aerobic exercise on serum leptin levels in obese women", Eur J Appl Physiol, 80(2): 154-158, 1999.

19- Locus, A., Verdun, M. and Heath, L.: "Low energy availability, not stress of exercise alters LH pulsitility in exercising women", J Appl Physiol, 84(1): 37-46, 1998.

20- Marshall, K.: "Polycystic ovary syndrome: Clinical consideration", Altern Med. Rev., 6(3): 272-292, 2002.

21- Mesquita, A., Trabulo, M., Mendes, M., Viana, J. and Seabra, G.: "The maximum heart rate in the exercise test: the 220- age formula or Shffeield's table", Rev Prot Cardiol, (Abstract), 15 (2): 139- 144, 1996.

22- Moran, L., Noakes, M., Clifton, P., Tomlinson, L. and Norman, R.: "Dietary composition in restoring reproductive and metabolic physiology in overweight women with polycystic ovary syndrome", J Clin Endocrinal Metab., 88(2): 812-819, 2003.

23- Nicklas, R., Rogus, E. and Goldberg, A.: "Exercise blunts declines in lipolysis and fat oxidation after dietary induced weight loss in obese older women", Am J Physiol, 273: E149 – E155, 1997.

24- Paradisi, G., Steinberg, H., Heupfling, A., Cronin, J., Hook, G., Shepard, M. and Baron, A.: "Polycystic ovary syndrome is associated with endothelial dysfunction", Circulation, 103 (10): 1410-1415, 2001.

25- Pasquali, R. and Casimirri, F.: "The impact of obesity on hyperandrogenism and polycystic ovary syndrome in premenopausal women", Clin Endocrinol, 39: 1-16, 1993.

26- Pasquali, R., Casimirri F. and Vicennati, V.: "Weight control and its beneficial effect on fertility women with obesity and polycystic ovary syndrome", Hum Reprod, 12 (1): 82-87, 1997.

27- Pasquali, R., Gambineri, A., Biscotti, D., Vicennati, V., Gagliardi, L., Colitta, D., Fiorini, S., Cognigni, G., Filicori, M. and Morsell-Labate, A.: "Effect of Long term treatment with metformin added to hypocaloric diet on body composition, fat distribution and androgen and insulin levels in abdominally obese women with and without the polycystic ovary syndrome", J Clin Endocrinol Metab, 85: 2767-2774, 2000.

28- Phipps, W.: "Polcystic ovary syndrome and ovulation induction", Obstet Gynecol. Clin. North Am., 28(2): 165-182, 2002.

29- Rao, G.: "Insulin resistance syndrome", Am Fam Physician, 63(6): 1159-1163, 2001.

30- Shangold, M.: "Responses of the ovarian hormones to exercise in women with

polycystic ovary syndrome", Eur J Endocrinol, 136: 488- 492, 1997.

31- Tochikubo, O., Miyajima, E., Okabe, K. and Imai, K.: "Improvement of multiple coronary risk factors in obese hypertensively women by reduction of intra abdominal visceral fat", Jpn L., (Abstract), 35 (6): 715-725, 1994.

الملخص العربي

تأثير النظام الغذائي والتمرينات وإذابة الدهون كهربيا على الهرمونات لدى السيدات البدينات المصابات بمتلازمة تكيسات المبايض

أجريت هذه الدراسة على 60 سيدة بدينة مصابة بمتلازمة تكيسات المبايض كمحاولة لمعرفة تأثير النظام الغذائي بمفردة أم مع التمرينات أو إذابة الدهون كهربيا على الهرمونات (الهرمون المحفز للتبويض و الهرمون المحفز لنمو حويصلة جراف وهرمون الأنسولين والهرمون الأنثوي لربط البروتين) ومعدل التبويض و الحمل.و تم تقسيم العينة عشوائيا إلى ثلاث مجموعات متساوية: مجموعة(ا) تم علاجهن عن طريق اتباعهن نظام غذائي و التمرينات و المجموعة (ب) تم علاجهن عن طريق اتباعهن نظام غذائي و إذابة الدهون كهربيا و المجموعة (ج) تم علاجهن عن طريق اتباعهن نظام غذائي فقط. وقد اتبعت جميع المجموعات نفس النظام الغذائي الذي يشتمل على 1200 سعر حراري يوميا و لمدة 4 شهور وهو زمن الدراسة.

وقد أظهرت النتائج تحسن إيجابي في جميع الهرمونات و معدل التبويض والحمل بعد 4 شهور من العلاج في المجموعة (ا) و (ب) و لم تكن النتائج إيجابية بصورة مقبولة في المجموعة (ج). وأيضا كانت هناك فروق إيجابية فيما بين المجموعات الثلاثة وكانت المجموعة (ب) أفضلهن في التحسن . مما سبق نستنتج أن التمرينات و إذابة الدهون كهربيا وسيلتان فعالتان لتحسين حالة الهرمونات ومعدل التبويض والحمل لدى السيدات البدينات المصابات بمتلازمة تكيسات المبايض مع العلم بأن إذابة الدهون كهربيا أفضل من التمرينات في علاج مثل هذه الحالات إضافة لاتباع النظام الغذائي .