Influence of Electro-lipolysis on Lipid Profile and Central Obesity in Obese Premenopausal Women

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ABSTRACT

The current study is carried out to determine the influence of electrolipolysis on reducing central obesity and improving lipid profile in obese premenopausal women. Thirty premenopausal obese women, their age ranged between 40 and 49 years, their BMI between 35 and 40 Kg/m^2, WHR between 0.90 and 0.95 and waist circumference between 90 and 105 cm, were selected from the outpatient clinic of gynecological department, faculty of medicine, Cairo University. They were assigned into two equal groups (A & B), each of them consisted of 15 participants. Participants of group (A) received electrolipolysis on the abdominal area and follow a low-calorie diet for three consecutive months. While, participants of group (B) followed a low-calorie diet alone for three consecutive months. Evaluation was done for both groups before and after treatment, to evaluate the body weight, waist circumference, waist hip ratio, body fat composition, lipid profile and abdominal fat thickness. Results of the study revealed a significant improvement in all measuring variables for both groups following treatment. On comparing results of both groups after treatment, the results revealed a statistically significant ($P<0.05$) decrease in weight, waist circumference, waist hip ratio, body mass index, triglyceride and low density lipoprotein with statistically significant increase in high density lipoprotein favoring group (A). Also, there was statistically highly significant ($P<0.01$) decrease in fat weight, cholesterol and abdominal fat thickness favoring group (A). The results of this study testified that the combination of electrolipolysisis and low-calorie diet characterized by a higher efficiency than a low-calorie diet alone on reducing central obesity and improving lipid profile in premenopausal obese women.

Key words: *Obesity, electrolipolysis, low-calorie diet, permenopause, central obesity, abdominal fat thickness.*

INTRODUCTION

Over the past three decades, the prevalence of overweight and obesity has increased several-fold. The World Health Organization (WHO) estimates that over one billion people are overweight globally, and that if current trends continue, that number will increase to 1.5 billion by 2015[32].

Obesity is common complaint among premenopausal women, with aging women metabolisms slow so that, reducing her caloric requirements and if her eating and exercises habits do not change a women may gain weight[20].

Moreover, weight gain during this period is usually associated with fat deposition in the abdomen[12]. Abdominal obesity is an excess body fat distributed around the waist more than 35 inches which increases the likelihood of developing insulin resistance and subsequent diabetes and heart diseases[21]. Numerous factors underline the weight gain that may occur during this period, including genetic factors neuropeptides, adrenergic nerves system activity and hormones[30]. Cardiovascular disease, the leading cause of death in women also it is an important health concern for the premenopausal women[33].

The prevalence of abdominal obesity in Egyptians' based upon the International Diabetes Federation (IDF) guidelines is 30.2% for men and 70.9% for women while based on new Egyptian criteria, the prevalence of abdominal obesity in men is 37.1% and in women 50.8%. A positive correlation was found between waist circumference (WC) and most of the cardio-metabolic risk factors[14].

Estrogen has a number of cardio protective benefits including favorable effects on blood lipids levels[29]. Estrogen deficiency adversely affect circulating lipid levels, leading to increase in low-density lipoprotein cholesterol, total serum cholesterol and triglyceride levels and a decline in high density lipoprotein cholesterol[20]. As women grow older, their rates of myocardial infraction and stroke approach exceed those of men[15].

A healthful diet, low in fat and high in grains, fruits and vegetables can benefit premenopausal women by reducing their risk of atherosclerotic disease, hypertension, osteoporosis, diabetes mellitus, cancer and obesity[10]. Regular exercise, along with moderate caloric control, will help women maintain a healthy weight and avoid the weight gain often associated with the premenopause[22,31].

Ryan et al. (2000)[28] suggested that changes in energy expenditure and dietary intake patterns may play a role in weight gain during menopause. In a longitudinal study of premenopausal women, they reported that women who experienced menopause had greater decreases in resting metabolic rate and leisure-time physical activity than did women of the same age who remained premenopausal. Both groups of women slightly increased their energy intake; thus, the women who experienced menopause had a significantly greater positive energy balance than did the premenopausal women.

Electrical muscle stimulation is a well-accepted treatment modality in the fields of medicine and physiotherapy. Literature highlights their effect on strength increase and the prevention of muscle wastage[1,6].

A strong association between the use of electrical stimulation and changes in the body shape[18]. As well as, it was found that transcutaneous electrical abdominal muscle stimulation for two months can significantly reduced body weight and visceral obesity in women[3].

Electrolipolysis uses a weak electrical current to effectively correct unaesthetic features related to localized or diffuse adiposity as well as lipodystrophy[5]. The low voltage current, low intensity impulses through electrodes implanted directly in adipose tissue is used as a signal to stimulate the sleeping adipocytes to eliminate their contents through three mechanisms firstly. The effect of electroliopolysis was mentioned by Kantor et al. (1994)[18] 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 monophosphate thus activated lipases.

Secondary electrolysis when a low frequency electrical current passing through the electrode creates magnetic field in the area which cause the sodium, chlorine and potassium ions to be moved through the cell membrane, the variations in the concentration of ions make it possible for the cells to break down and eliminate the metabolites and excess fluid through the normal excretion channels[2].

Finally the electrical current gently stimulation the muscular fibrils and the collagen fiber which constitutes the walls of the small blood vessels and stimulates the adrenergic interstitial nerve ending which will cause vasodilatation and activation of lipases by boosting the cholaminergic effect[19].

Porcari et al. (1997)[24] reported that when a muscle contract as a result of electrical stimulation, the chemical changes taking place within the muscle are similar to those associated with voluntary contractions in normal exercising. The chemical reactions which results form muscle contractions utilities glycogen fat and other nutrients stored around the muscles.

So, this study was designed as a trial to determine the effectiveness of electrolipolysis and low caloric diet in reducing the body weight and central obesity among premenopausal obese women.

MATERIALS AND METHODS

Subjects

Thirty premenopausal abdominally obese women, their age ranged between 40 and 49 years, their BMI between 35 and 40 Kg/m^2, WHR between 0.90 and .95 and waist circumference between 90 and 105 cm, were selected from the outpatient clinic of gynecological department faculty of medicine, Cairo University.

All women free from any medical disorders as diabetes mellitus, thyroid dysfunction or concomitant cardiovascular respiratory, renal and liver dysfunctions or on medication known to effect carbohydrate or lipid metabolism were excluded from the present study. Premenopausal status was as

certain by self report on the basis of regularity of the menstrual cycle at physical examination.

All women signed informed consent after reading it and hearing verbal explanations and were randomly divided into two groups equal in numbers. Group (A) received electrolipolysis on the abdomen with low calorie diet while, Group (B) received low calorie diet alone.

Materials

Assessment tools:

1- Weight height scale for measuring the weight and height.
2- A one centimeter wide measuring tape to measure waist and hip circumference.
3- Bio Dynamics (model 310) whole body bio-impedance analyzer to measure percentage body fat, and fat weight for all women in both groups (A & B) before starting and after the end of the study.
4- Ultrasound device: GE Loge 200 Alpha Ultrasound Machine was used to measure the abdominal fat thickness for all women in both groups (A & B) before starting and after the end of the study

Treatment tools:

Body program slimy (model number IGC 601-1) with four channels used for the application of electrolipolis in group (A).

Methods

a- Evaluative procedures:

- Anthropometric measurement: Height and body weight were measured with women wearing light clothes and bare feet also, body mass index in which the weight in kilograms divided by the square of the height in meters and waist to hip circumference they were evaluated over single layer of clothing with women standing in an a erect position with feet together waist circumference it was obtained at level of umbilicus with normal respiratory pattern while, Hip circumference it was obtained at the level of greater trochanter then the waist to hip ratio was calculated.

- Bioelectrical impedance measurements: The measurements were made about two hours after eating. Woman lied on supine lying position, after cleaning all skin contact area with alcohol aluminum foil spot electrodes were placed on the dorsal surfaces of the hands and feet at the distal metacarpals and metatarsals respectively and also between the distal prominences of the radius and ulna and between the medial and lateral malleoli at the ankle and clips attached these spot electrodes to the analyzer, the height, weight, age and sex were feed into then analyzer. After calibrators of the machine a painless localized electric signal was started to ran through the body tissue and impedance to current flow was determined the impedance to current flow was converted to represent the fat weight, and percent of body fat.

- Ultrasonographic Examination: With the women lying in a supine position. Skin of the anterior abdominal wall was cleaned with alcohol then gel was applied to the examined area. The linear-array probe was kept perpendicularly to the skin on the upper median abdomen and longitudinal scanning was started from the end of xiphoid process down to the pubic bone. Each measurement was performed without compression of the abdominal wall with the transducer. Abdominal subcutaneous fat thickness i.e. the maximum distance from the subcutaneous tissue to the linea alba, is measured at three levels:

- At the level of the umbilicus.
- Above the level of the umbilicus by 5cm.
- Below the level of the umbilicus by 5cm.

- Plasma lipoprotein- lipids profile: A venous blood samples were collected from each woman after twelfth hours over night fast for the measurement of plasma lipid and lipoprotein level. The samples were collected in plain tubes and were transported to the laboratory. Serum was removed and stored at 50ºC for measurement of triglyceride, total cholesterol low density lipoprotein and high density lipoprotein.

b- Treatment procedures:

- Electrolipolysis treatment: only in group (A) before starting treatment sessions each woman was asked to evacuate her bladder to make sure that she was comfortable and relaxed. Then the women lied in the supine lying positions. Electrical stimulation was delivered via eight surface electrodes (Unipatch Encore Plus silver, 7.5 cm in diameter, Wabasha, MN). Two pairs of electrodes were placed on the lower abdomen, near the midline and just above iliac crest on the right and left side. Two other pairs of electrodes were placed on the

upper abdomen near midline just below the ribs; acing between the electrodes edges was approximately 3 cm on the right and left side. The treatment started with contraction time for four seconds followed by another four seconds of relation time, the machine adjusted at 20 pulses/minutes was set manually by the investigator based visual inspection of the contraction obtained (Up to maximum approximately 400mA) the machine was automatically switched off when the session time ended (60 minutes).

- Diet protocol: The diet principle in both groups assured that energy intake was 500K calorie below daily requirements on average three meals at the same time of the day. The composition of the dietary regimen was: carbohydrates (55%), Proteins (30%), Fat (15%), and 2 Litters of fluids were included daily. This regimen was very similar to the Mediterranean style step (I) diet, which is advised by the American Heart Association as possible tool to lower cardiovascular risks[27]. All women were encouraged to have physical activity at least one hour walk three times a week.

Statistical Analysis

Changes in the measured variables (anthropometric, bio-impedance, fat thickness, plasma lipids and lipoprotein measurements) were collected and statistically analyzed by using mean, standard deviation, paired and unpaired t-test to compare between before and after three months of treatment in each group as well as comparing both groups following the treatment programs at a confidence of 95% (α-level of 0.05).

RESULTS

The results of the present study showed that:

- The anthropometric measurements results post treatment revealed a statistically highly significant (P<0.01) decrease in weight and waist circumference However, there was statistically significant (P<0.05) decrease in waist hip ratio and Body mass index for both groups (A&B). While, the results of bioelectrical impedance showed a highly significant (P<0.01) decrease in fat weight in both groups following treatment with highly significant decrease in fat percentage in group (A) and statistically significant (P<0.05) decrease in in fat percentage in group (B) (Table 1).

Table (1): Shows the mean values and standards deviations of anthropometrics and bio-electrical impedance measurements before and after treatment in both groups.

			Mean	SD	X -diff	% of change	t-test	P value	Sig.
Weight (Kg)	Group (A)	Before	95.80	5.69	12.53	-13.08	17.34	Hs	0.00
		After	83.27	6.09					
	Group (B)	Before	96.77	5.63	7.57	-7.82	13.44	Hs	0.00
		After	89.20	6.52					
Circumference	Group (A	Before	96.47	4.81	10.27	-11.64	6.98	Hs	0.00
		After	86.20	3.59					
	Group (B)	Before	97.33	5.09	9.00	-9.25	9.36	Hs	0.00
		After	88.33	5.79					
Waist hip ratio (%)	Group (A)	Before	0.92	0.01	0.13	-13.74	16.88	S	0.01
		After	0.80	0.01					
	Group (B)	Before	0.93	0.01	0.06	-6.84	28.77	S	0.04
		After	0.87	0.01					
BMI (Kg/m^2)	Group (A)	Before	37.10	2.57	4.83	-13.1	18.72	S	0.01
		After	32.27	2.82					
	Group (B)	Before	36.24	1.49	3.13	-8.64	16.01	S	0.03
		After	33.11	1.91					
Percent of body fat (%)	Group (A)	Before	41.35	2.10	4.46	-25.70	10.65	Hs	0.00
		After	36.88	2.40					
	Group (B)	Before	41.29	1.82	1.34	-25.13	6.57	S	0.02
		After	39.95	2.26					
Fat weight (Kg)	Group (A)	Before	32.13	2.92	9.06	-28.19	15.61	Hs	0.00
		After	23.07	2.01					
	Group (B)	Before	32.50	2.32	4.58	-14.09	6.15	Hs	0.00
		After	27.92	3.73					

X –diff: mean difference S: significant Sig.: significance SD: standard deviation
Ns: non-significant Hs: high significant P value: probability value

- The lipids profile results in group (A) showed a statistically, highly significant (P<0.01) decrease in Triglyceride and total cholesterol and low density lipoprotein with statistically highly significant increase in High density lipoprotein after treatment. The results of group (B) after treatment. showed a statistically, highly significant (P<0.01) decrease in Triglyceride and total cholesterol with significant (P<0.05) decrease in low density lipoprotein and significant increase in High density lipoprotein after treatment. [table (2) and fig. (1)].

Table (2): Shows the mean values and standards deviations of lipids profile before and after treatment in both groups.

			Mean	SD	X -diff	% of change	t-test	P value	Sig.
Triglyceride (mg/dl)	Group (A)	Before	167.00	4.36	21.93	-13.13	15.62	Hs	0.00
		After	145.07	5.69					
	Group (B)	Before	167.06	5.81	17.80	-10.65	11.13	Hs	0.00
		After	149.26	5.62					
Total cholesterol (mg/dl)	Group (A	Before	214.20	7.34	41.66	-19.44	17.59	Hs	0.00
		After	172.53	4.42					
	Group (B)	Before	215.46	7.36	22.06	-10.23	12.38	Hs	0.00
		After	192.40	5.35					
Low density lipoprotein (mg/dl)	Group (A)	Before	145.73	3.28	23.06	-15.82	16.53	Hs	0.00
		After	122.66	4.93					
	Group (B)	Before	146.03	3.60	16.70	-11.44	8.89	S	0.01
		After	129.33	4.56					
High density lipoprotein (mg/dl)	Group (A)	Before	46.13	2.83	-3.73	8.08	-5.65	Hs	0.00
		After	49.86	2.13					
	Group (B)	Before	45.87	2.36	-2.46	5.36	-3.77	S	0.03
		After	48.33	2.19					

X –diff: mean difference S: significant SD: standard deviation
P value: Level of Significant Hs: high significant mg/dl: milligrams/ deciliter

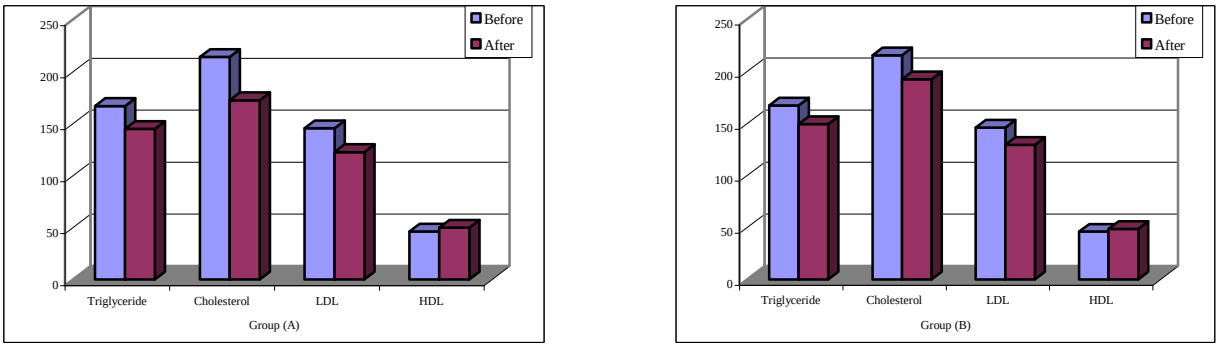

Fig. (1): Lipids profile before and after treatment in both groups (A&B).

When pre and post treatment abdominal fat thickness were measured , the results showed a statistically, highly significant (P<0.01) decrease in abdominal fat at all levels (umbilical, above & below umbilicus) in group (A) after treatment while, there was a statically significant (P<0.05) decrease in abdominal fat at all levels in group (B) after treatment as shown in [table (3) and fig. (2)].

Table (3): Shows the mean values and standards deviations of fat thickness before and after treatment in both groups.

			Mean	SD	X -diff	% of change	t-test	P value	Sig.
At level of umbilicus (mm)	Group (A)	Before	38.95	3.36	15.65	-40.18	30.42	Hs	0.00
		After	23.30	2.36					
	Group (B)	Before	39.80	2.86	3.65	-9.17	3.99	S	0.01
		After	36.15	4.42					
Above level of umbilicus (mm)	Group (A	Before	37.66	3.41	14.93	-39.64	18.34	Hs	0.00
		After	22.73	2.83					
	Group (B)	Before	37.40	4.30	3.94	-10.52	3.67	S	0.01
		After	33.46	3.20					
Below level of umbilicus (mm)	Group (A)	Before	38.35	4.18	-15.30	-39.90	-21.98	Hs	0.00
		After	23.05	2.96					
	Group (B)	Before	37.30	4.43	-3.90	-10.45	-4.07	S	0.01
		After	33.40	3.07					

X –diff: mean difference S: significant SD: standard deviation
P value: Level of Significant Hs: high significant

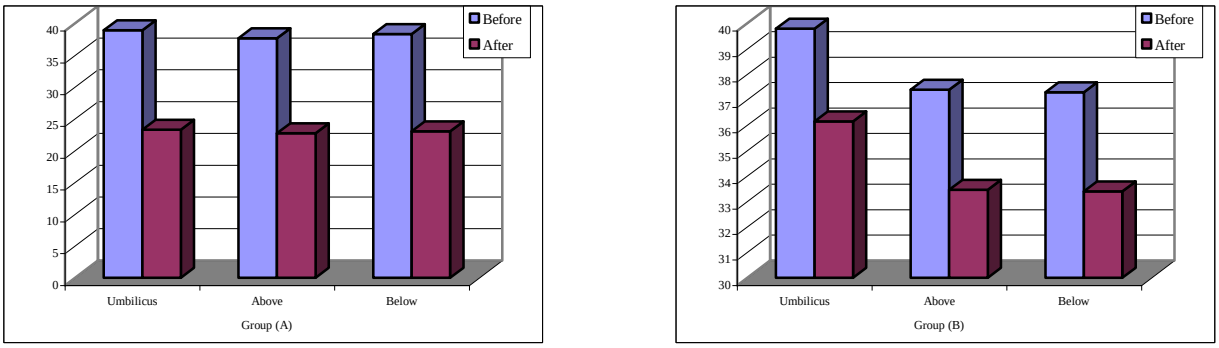

Fig. (2): Abdominal fat thickness (mm) before and after treatment in both groups (A&B).

On comparing post treatment results of both groups, the results revealed a statistically significant (P<0.05) decrease in weight, waist circumference, waist hip ratio, Body mass index, Triglyceride and low density lipoprotein with statistically significant increase in High density lipoprotein favoring group (A). Also, there was statistically highly significant (P<0.01) decrease in Fat weight, Cholesterol and abdominal fat thickness at all levels (umbilical, above & below umbilicus) favoring the same group (A) as shown in table (4).

Table (4): Comparison between anthropometrics measurements, bio-electrical impedance lipid profile and abdominal fat thickness of both groups (A&B) after treatment.

Variable		Group(A)	Group(B)	Diff.	% of difference	P-value	Sig.
Anthropometric measurements	Body weight	83.27±6.09	89.20±6.52	5.93	7.12	0.01	S
	WC	86.20±3.59	88.33±5.79	2.13	2.47	0.04	S
	WHR	0.80±0.01	0.87±0.01	0.07	8.75	0.01	S
	BMI	32.27±2.82	33.11±1.91	0.84	2.6	0.03	S
Bioelectrical impedance	Fat %	36.88±2.40	39.95±2.26	3.07	8.32	0.01	S
	Fat wt	23.07±2.01	27.92±3.73	4.85	21.2	0.00	HS
Lipid profile	Triglycerides	145.07±5.69	149.26±5.62	4.19	2.88	0.04	S
	Cholesterol	172.53±4.42	192.40±5.35	19.87	11.52	0.00	HS
	LDL	122.66±4.93	129.33±4.56	6.67	5.44	0.02	S
	HDL	49.86±2.13	48.33±2.19	1.53	3.07	0.03	S
Fat thickness	Level of umbilicus	23.30±2.36	36.15±4.42	12.85	55.15	0.00	HS
	Above umbilicus	22.73±2.83	33.46±3.20	10.73	47.21	0.00	HS
	Below umbilicus	23.05±2.99	33.40±3.07	10.35	44.90	0.00	HS

WHR: waist hip ratio WC: waist circumference BMI: body mass index
LDL: low density lipoprotein HDL: high density lipoprotein

DISCUSSION

Weight gain during the middle years has been shown to be associated with greatly increased risk of a range of chronic and debilitating illness. Prevention of middle-age weight gain has major positive effects on adult health. Prevention of weight gain prevents most adult-onset diabetes, reduces the development of hypertension and reduces lipid disorders. All of these factors in turn reduce the risk of heart disease[13].

Obesity, particularly with central fat distribution being a powerful predictor of risk of coronary heart disease and mortality are directly related in middle-aged women. Many studies have shown that women in their midlife tend to gain weight, with a shift to visceral fat distribution[21].

One of the most popular areas in the esthetic medical field is the removal and/or reduction of subcutaneous fat cell number and adipose tissue volume which result in the reshaping of body parts, frequently referred to as "body contouring". To date, various techniques have been proposed to aid in the task of lowering the number and/or volume of fat cells and adipose tissue volume[26].

This study was designed to determine the effectiveness of electrolipolysis and low caloric diet in reducing the body weight and central obesity among premenopausal obese women.

Tochikubo et al. (1994)[30] who used transcutaneous 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, Irving et al., (2008)[16], 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.

Other explanation about the effect of electrolipolysis was mentioned by Kantor et al. (1994)[18] 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 monophosphate thus activating lipasis.

Regarding the results of anthropometric variables. The weight loss decrease in BMI in this study after low caloric diet may attributed to several mechanisms including, the diuresis and depletion in stored glycogen and reduction in fat mass the depletion of fat depot caused by hydrolysis and clearance of triglyceride stored in adipose tissue into glycerol and free fatty acid (FFA) by the action of lipoprotein lipase (LPL)[10]. Results of previous studies showed that more than a 10% reduction in body weight in a three months period of diet regimen[11]. Other studies have reported similar weight losses in the range of 10 to 13 kg in obese women undergoing 16 weeks diet programs[8] and it was also reported that significant body weight losses, 14.5% compared to baseline over 16 week diet regimen[21].

Also the decrement in Waist circumference and waist hip ratio may be explained by decrement in body fat mass in the abdominal region. It may also be related to regional change in LPL activity in the abdominal fat area. This lead to mobilization of FFA from centrally distributed adipose tissue. This is in agreement with Astrup and Rossner, (2002)[4] showed that post menopausal women appear to lose more fat from abdominal region during diet regimen. In contrast Clifton et al. (2002)[8] found that in obese post menopausal women, weight loss does not affect the regulation of regional fat metabolism and a greater tonic inhibition of basal lipolysis by endogenous adenosine that may increase the activity of adipose tissue LPL after weight loss and predispose older women to develop abdominal obesity. In addition, the results of this study showed a reduction of body fat mass in group A and B.

The change in fat mass may be due to several possible mechanisms including, shifting in substrate utilization, decrease in

proteolytic counter regulatory hormones and increase in lipo-protein lipase activity which could explain the change in fat mass[4].

In this study premenopausal women showed high levels of plasma lipoproteins-lipids profiles before the study and their metabolism were significantly influenced by treatment programs. The noticed lowering in plasma lipids may be related to the postulated decreased synthesis of VLDL, which in turn lowers the formation of LDL in the plasma compartment or increase hepatic B/E receptor[33].

The increase in HDL is related to the strong negative association exists between plasma TG-rich lipoprotein and HDL cholesterol, manipulations that modify plasma TG will also affect HDL cholesterol concentration[21].

The results of the current study are also supported by Pricharha et al. (2003)[25] who postulated that weight loss over 3 months period lowered plasma concentration of LDL, TG, TC and raised plasma HDL and cause reduction of subcutaneous fat. On the other hand, the results of this study contradict other studies reporting a negative correlation between BML WHR and blood lipids or between BMI and total cholesterol[12].

So, it could be concluded that the combination of electrolipolysis and low caloric diet has a positive effect on reducing central obesity and improving lipid profile in premenopausal obese women.

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الملخص العربي

تأثير التحليل الكهربائي على الدهون المتراكمة بالبطن لدى السيدات البدينات قبل انقطاع الطمث

أجريت الدراسة الحالية لتحديد تأثير التحليل الكهربائي للدهون على القياسات الإكلينيكية (الوزن- مؤشر كتلة الجسم - دوران الوسط-) والقياسات المعملية (مستوى الدهون في الدم) وكذلك سمك الدهون في منطقة البطن لدى السيدات البدينات قبل انقطاع الطمث . وقد اشتركت في هذه الدراسة 30 سيدة بدينه في مرحلة ما قبل انقطاع الطمث تعانى من سمنة موضعية بالبطن وقد تم تقسيمهن عشوائيا إلى مجموعتين متشابهتين . تكونت كل منهما من 15 مريضة . المجموعة الأولى (أ) تلقت برنامج التحليل الكهربائي للدهون بمعدل ثلاث جلسات أسبوعيا إلى جانب برنامج غذائي منخفض السعرات لمدة ثلاثة شهور . المجموعة الثانية تلقت برنامج غذائ ي منخفض السعرات فقط خلال فترة الدراسة . وقد تم تقييم جميع المشاركات عن طريق قياس الوزن والطول ودوران الوسط ومؤشر كتلة الجسم. إلى جانب قياس كمية الدهون في الدم وسمك الدهون في منطقة البطن قبل وبعد نهاية 3 شهور هي مدة الدراسة . وأوضحت النتائج وجود فروق ذات دلالة إحصائية واضحة بمقارنة نتائج ما قبل و بعد الدراسة لكلتا لمجموعتين.وكذلك أوضحت النتائج وجود فروق ذات دلالة إحصائية عالية لمجموعه (ا) عند مقارنة نتائج ما بعد العلاج للمجموعتين في نهاية البرنامج العلاجي . ومن هذه النتائج يتضح أن استخدام التحليل الكهربائي للدهون له تأثير فعال على تقليل سمنة البطن وتحسين مستوى الدهون في الدم لدى السيدات البدينات قبل انقطاع الطمث .

الكلمات الدالة : السمنة - التحليل الكهربائي للدهون - برنامج غذائي منخفض السعرات – مرحلة ما قبل انقطاع الطمث- سمنة البطن.