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Effect of Ultrasonic Lipocavitation on Normal Lipid Profile in Healthy Subjects

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ABSTRACT

This study was conducted to investigate the effect of low frequency ultrasonic lipocavitation on normal lipid profile in healthy subjects with localized fat deposits in abdomen. Design: one group repeated measure. *Subject, material and method:* forty eight volunteer healthy women participated in the study, their age was (25- 45) years old and their BMI was (25- 35) Kg/m^2. All of them adhered to balanced healthy diet to maintain body weight and received 12 sessions of ultrasonic lipocavitation on abdominal area along 6 weeks with session frequency of 2 sessions weekly and session duration of 25 min with ultrasonic Frequency of 32 -36 KHz, Output Power of 10-70 Watt/cm2. Lipid profile, BMI, WC, AC, WHR, BFM and TF were measured before treatment, after 4 weeks of treatment and repeated again at the end of treatment after 6 weeks. Results showed a significant decrease in values of TC, TGs, LDL, WC, AC, WHR, BFM and TF mass. Also significant increase in HDL favoring "post 4 weeks of treatment" and " post 6 weeks of treatment " in compare to pretreatment and favoring post 6 weeks in compare to post 4 weeks of treatment. *Conclusion:* Low frequency ultrasonic lipocavitation was effective in improving lipid profile and reducing abdominal localized fat deposits.

Key words: ultrasound cavitation, abdominal adiposity, lipid profile

Introduction

Obesity has become a major social and health problem, and is a risk factor for many diseases, like diabetes mellitus, hypertension, coronary heart disease, airway obstruction and malignant tumors (Mokdad *et al.,* 2001).

Obesity or being overweight in mammals depends mainly on amount of body fat present in adipose tissue layers, and not on body weight. (Kershaw *et al.,* 2004).

A person is considered obese when the amount of adipose tissue is sufficiently high to prejudicially alter biochemical and physiologic function and to shorten life expectancy. There are four major risk factors of atherosclerosis are associated with obesity, they are: hyper tension, diabetes, hypercholesterolemia and hypertriglyceridemia (Manson *et al.,* 1995).

The use of ultrasonic cavitation or lipocavitation is well known as a noninvasive treatment which helps in the reduction of localized fat deposits. This method is used for people who are dissatisfied with a certain area of fatty deposits but who do not want to undergo any invasive surgical treatment like liposuction. It is performed as a walk in, walk out treatment and there is no lengthy recovery period as with surgical fat removal (Victor, 2013).

The idea of working in Ultrasonic lipocavitation is: an ultrasound energy with frequency range of 20–70 KHz will be irradiated at certain depth in a convergent way and concentrated at a certain point to produce unlimited small vacuum bubbles (fat bubbling). These bubbles are pressured, and then they will break the bonds among fat cells, destroy the membrane walls of the fat to form "cavitations" (holes in the fat layer) and drain them into the lymphatic vessels to be excreted from the body. These fat-soluble particles changed into 3 new elements: triglycerides, free fatty acids water. Furthermore, triglycerides will be metabolized in the liver, free fatty acids will be used by muscles for energy and water will be disposed in the kidney (Brown *et al.,* 2009).

Lipid profile measures total cholesterol (TC), high density lipoproteins (HDL) cholesterol, low density lipoproteins (LDL) cholesterol and triglycerides (TGs). A physician may order a lipid profile as part of annual exam or if there is specific concern about cardiovascular diseases (CVD), especially coronary heart diseases (CHD) (Birtcher *et al.,* 2000).

Cavitation effect on fat tissue lead to fat fragmentation and the subsequent spread of the lipid matrix that later joins to the interstecial fluids. Emulsified fluid content is transferred through vascular

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and lymphatic tracts to the liver. When it reaches the liver, it follows the organism's normal mechanisms (Teitelbaum *et al.,* 2007).

Therefor the current study was conducted to investigate the influence of low frequency US cavitation (using US frequency range of 32 KHz -36KHz) on all component of lipid profile (TC, TGs, HDL and LDL) in normal, healthy subjects.

Subjects, Materials and Methods

Subjects:

This one group repeated measure study included forty eight volunteer healthy women their mean ± standard deviation for age and height were 30.29±2.86 years and 162.29±4.91 cm respectively, their body mass index (BMI) was in range (25-35) kg/m2 having localized fat deposits in abdomen, all of them signed informed consent. The sample size was determined by power analysis with power set at 80%, α =0.05 and medium effect size (f= 0.25).

All participants were free from chronic diseases such as diabetes, hypertension, cardiovascular diseases, renal and hepatic diseases. They all had not had any history of blood lipid disorders or hyperlipidemia. They all were free from any muscloskeletal and neural disorders. And any condition was receiving fat burner drugs or any recent application of modalities for local fat reduction were excluded from this study.

Materials:

Instrumentation:

Balance Beam Weight Scale With Height Measure was used for weight and height measurements, A one centimeter wide measuring tape was used for measurements of waist, abdomen and hip circumference and Inbody 230 - Body Composition Analyzer to measure body weight (BW), BMI, body fat mass(BFM) and trunk fat (TF) before and after treatment. Megason device (EunSung Global Co Ltd., Seoul, Korea) was used for application of ultrasonic cavitation with ultrasonic Frequency of 32 KHz -36KHz,Output Power of 10-70 Watt (Mohammadzadeh*, 2015).*

Methods:

Height was measured for each participant and Anthropometric measurements, including BW, BMI, BFM and TF were obtained using Inbody 230 - Body Composition Analyzer device.

Waist, abdomen and hip circumference were evaluated over single layer of clothing from standing in an erect position with feet together waist circumference (WC) was measured at level midway between the costal margin and iliac crest at the end of normal expiration while, Hip circumference (HC) was measured at the level of greater trochanter then the waist to hip ratio (WHR) was calculated. Abdomen circumference (AC) was measured at the maximum point below the level of umbilicus.

Lipid profile was investigated before proceeding with ultrasound lipocavitation sessions for all participants: A venous blood samples were collected from each woman after 12^{th} hours over night fast. The samples were collected in plain tubes and were transported to the laboratory to investigate TC, TGs, HDL and LDL and cases of abnormal lipid profile were excluded.

Subjects were instructed to start drinking from the week before the session, at least 1.5 – 2 liter of water per/day to stimulate the purifying action of the liver and kidneys (Jasminka *et al., 2010).*

All subjects received a balanced healthy diet to maintain body weight and treated locally by ultrasonic lipocavitation (Saber *et al.,* 2013).

Balanced healthy diet was obtained by calculating caloric daily requirements: through applying Harris-Benedict principle using the estimated value of basal metabolic rate (BMR) from the following equation [BMR = 655.1 + (9.563 x weight in kg) + (1.850x height in cm – (4.676 x age in years)], multiplied by a number that corresponds to the person's activity level *(Santos et al., 2011).*
Therefor the calculation of daily calorie intake to maintain current weight was as follow:

- Little to no exercise: Daily calories required = BMR x 1.2
- Light exercise: Daily calories required = BMR x 1.375

- Moderate exercise: Daily calories required = BMR x 1.55
- Heavy exercise: Daily calories required = BMR x 1.725
- Very heavy exercise: Daily calories required = BMR x 1.9) (Saber *et al.,* 2013).

Then all subjects underwent 12 sessions of ultrasonic lipocavitation on abdomen with session duration of 25 min along 6 weeks. The frequency of session was 2 sessions per week.

Lipid profile investigation, Body composition analysis, WC measurements, AC measurements and WHR was repeated after 4 weeks of treatment and at the end of treatment (after 6 weeks). The sample collection was performed after 48 hours from the last session.

Statistical analysis:

Statistical analysis was conducted using SPSS for windows, version 23 (SPSS, Inc., Chicago, IL). Repeated measure MANCOVA was used to compare the tested variables of interest at different tested conditions, the body mass and body mass index were used as covariates at each measuring periods. All data were presented as mean ± SD. With the alpha level: 0.05.

Results

Results of lipid profile in the current study showed statistically significant decrease in mean values of TC, TGs and LDL as revealed by the univariate test of repeated measure MANCOVA with (P= 0.0001*). Also multiple pairwise comparison tests (Post hoc tests) revealed significant differences between different measuring periods with (p=0.0001*). And statistically significant increase in mean value of HDL, among different conditions as revealed by the univariate test with (P=0.0001*). Also post hoc tests revealed significant differences between (pretreatment Vs. post 4 weeks of treatment), (pretreatment Vs. post 6 weeks of treatment) and (post 4 weeks Vs. post 6 weeks of treatment) with (p=0.001*, p=0.0001* and p=0.0001*) respectively {table (1) and fig (1,2,3&4)}.

Table 1: Descriptive statistics and one way MANCOVA for the lipid profile at different measuring periods.

		Mean ±SD	The univariate tests		Post hoc tests	
					Test	**P value**
Total cholesterol	**Pretreatment**	173.2±14.46	F= 133.724	P= 0.0001*	Pretreatment Vs. post 4 weeks	0.0001*
	Post 4 weeks	161.87±13.19			Pretreatment Vs. post 6 weeks	0.0001*
	Post 6 weeks	148.87±16.79			post 4 weeks Vs. post 6 weeks	0.0001*
Triglycerides	**Pretreatment**	80.27±14.75	F= 38.179	P= 0.0001*	Pretreatment Vs. post 4 weeks	0.0001*
	Post 4 weeks	72.66±11.37			Pretreatment Vs. post 6 weeks	0.0001*
	Post 6 weeks	65.66±7.73			post 4 weeks Vs. post 6 weeks	0.0001*
HDL	**Pretreatment**	46.33±7.65	F= 50.382	P= 0.0001*	Pretreatment Vs. post 4 weeks	0.001*
	Post 4 weeks	50.14±3.95			Pretreatment Vs. post 6 weeks	0.0001*
	Post 6 weeks	54.25±4.11			post 4 weeks Vs. post 6 weeks	0.0001*
LDL	**Pretreatment**	108.67±14.16	F= 144.001	P= 0.0001*	Pretreatment Vs. post 4 weeks	0.0001*
	Post 4 weeks	99.27±14.12			Pretreatment Vs. post 6 weeks	0.0001*
	Post 6 weeks	82.56±20.15			post 4 weeks Vs. post 6 weeks	0.0001*

*Significant at alpha level <0.05

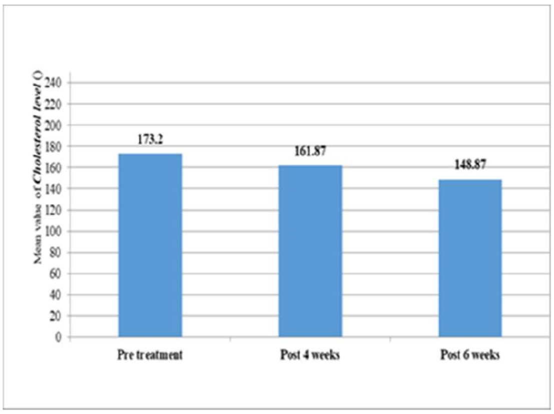

Fig. 1: Mean values of the TC level at different measuring periods

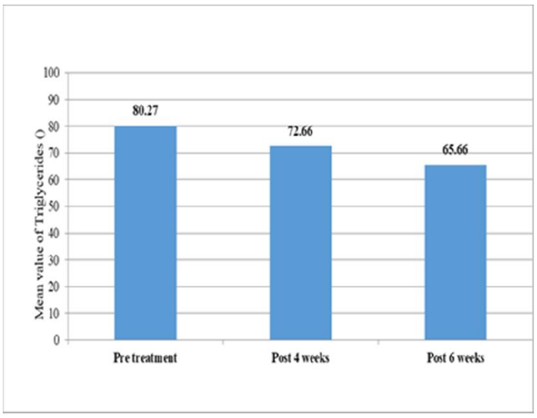

Fig. 2: Mean values of the TGs level at different measuring periods

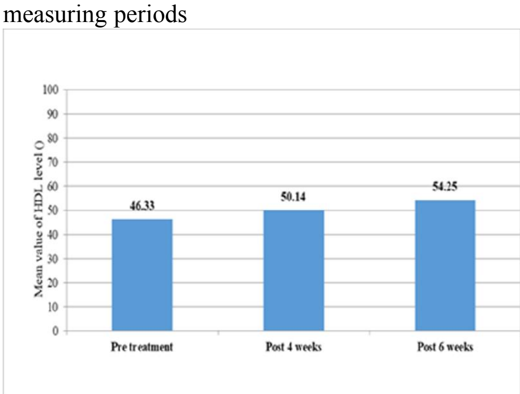

Fig. 3: Mean values of the HDL level at different measuring periods.

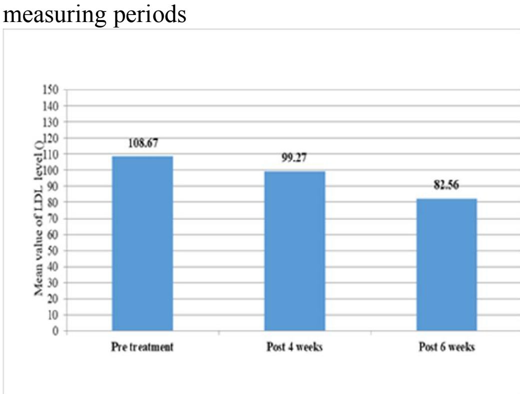

Fig. 4: Mean values of the LDL level at different measuring periods.

Results also showed significant decrease in mean values of WC, AC, WHR, BFM and TF among different conditions as revealed by the univariate test with (P= 0.0001*). Also Post hoc tests revealed significant differences between different measuring periods with (p=0.0001*). These significant differences in favor to "post 4 weeks of treatment" and " post 6 weeks of treatment " in compare to pretreatment and in favor to post 6 weeks in compare to post 4 weeks of treatment

In the current study the interaction between the time and (BW pre, post1 and post 2 and BMI pre, post1 and post 2) was not significant, which indicates that the effect of time on the other dependent variables(TC, TGs, HDL, LDL, WC, AC, WHR, BFM and TF) was not influenced by the (BW pre, post1 and post 2 and BMI pre, post1 and post 2) (F=0.446, P=0.959), (F=0.362, P=985), (F=0.998, P=0.493), (F=0.515, P=0.924), (F=1.062, P=0.438) and (F=0.1.544, P=0.158) respectively.

Discussion

This one group repeated measure study was designed to evaluate the effect of ultrasonic lipocavitation on lipid profile of normal healthy subjects with localized fat deposits in abdomen.

In this study three components of lipid profile (TC, TGs and LDL) showed significant reduction after 4 weeks of treatment with ultrasonic lipocavitation on abdomen and adherence to balanced healthy diet to maintain body weight, and that decrement persisted also to the end of treatment after 6 weeks. While HDL showed significant increase after 4 weeks of treatment and that increase persisted also to the end of treatment after 6 weeks.

That improvement 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 (Zamboni *et al.,* 1993).

That improvement also may be related to the significant reduction in body fat mass and abdominal fat mass as it is known that central obesity is more strongly related to lipid /lipoprotein abnormalities than general obesity (Seidell *et al.,* 1991 and Walton *et al.,* 1995).

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 (Brochu *et al.,* 2000).

Results of lipid profile of the current study is supported by those of (Sabbour and El-Banna, 2009) and (El-Hamed *et al.,* 2014) who achieved high significant improvement in lipid profile using ultrasound cavitation frequency of 40 KHz, Sabbour *et al.,* 2009 achieved more significant improvement in lipid profile using ultrasonic cavitation combined with low caloric diet than low caloric diet alone which supports our results.

On the other hand these results contradicted with those of Tonucci *et al.,* (2014); Saber *et al.,* 2013, Savoia *et al.,* (2010) *and* Jasminka *et al.,* (2010). Which showed no alterations in lipid profile before and after treatment with ultrasound lipocavitation .

Tonucci *et al.* (2014) found no significant differences in lipid profile when measured before treatment, after the 1st session and at the end of treatment with U.S.C using 37.2-42.2 KHz US frequency and 3W/CM2 cavitation power through 5 sessions of treatment in 2 weeks with session duration of 60-90 minute and life style of nutrition maintained.

Saber *et al.* (2013) also found no significant differences in lipid profile of normal healthy female subjects when applied ultrasound lipocavitation on gluteal area using U.S frequency of 40 KHz and cavitation power of 2.5 w/cm2 along 6 weeks of treatment with session duration of 15 min.

Savoia *et al.* (2010) reported no alterations in lipid profile of normal healthy subjects(50 subjects: male and female) before and after treatment with low frequency ultrasound cavitation on different body areas (abdomen, arms, buttocks and thighs) using ultrasound frequency of 30-70KHz for 8 consecutive weeks at frequency of 1session every 15 days when lipid profile investigated before treatment and after7 days from the 1st session aiming to confirm safety of low frequency ultrasound cavitation on lipid profile.

Jasminka *et al.* (2010) also performed repeated measuring for lipid profile before treatment with low frequency ultrasound cavitation, within 24 hours of treatment and 30 days after treatment and provide no significant alterations in lipid profile.

Briefly this disagreement with our results of lipid profile may be related to the different method and parameters like; different U.S frequency, different treatment period, different session duration and different interval time between sessions. And also may be related to the different timing of lipid profile investigation as the purpose of measuring lipid profile in these studies was to ensure safety of ultrasonic lipocavitation on lipid profile, while the main purpose of the current study was to evaluate the effect of ultrasonic lipocavitation on lipid profile of normal healthy subjects with localized fat deposits in abdomen.

In the current study the efficiency of ultrasound lipocavitation was achieved and approved by the significant reduction in waist circumference (WC), abdomen circumference (AC), waist/hip ratio (WHR), body fat mass and trunk fat mass.

Here in this study the average reduction in WC was 4.87 cm after 4 weeks of treatment and continued to reach 8.96 cm loss in WC at the end of treatment(after 6 weeks) and as a consequent WH R showed average reduction of 0.04 after 4 weeks and 0.08 after 6 weeks of treatment. Also loss in AC was 6.9 cm after 4 weeks of treatment and continued to reach 9.98 cm after 6 weeks of treatment.

The reduction in WC, AC and WHR may be explained by the reduction in body fat mass in the abdominal region caused by the cavitation mechanism (Brown *et al.,* 2009)

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 (Murray *et al.* 2005).

Of interest to mention that the reduction in body fat mass and trunk fat mass after 6 weeks of treatment was 1.44 kg and1.32 kg respectively.

These results regarding the efficiency of ultrasound lipocavitation are consistent with those of previous studies like (Mohammadzadeh *et al.,* 2015) who achieved 2.31kg reduction in fat mass, 1.38 kg loss in trunk fat, 3.76cm average loss in WC and 9.51 average loss in AC, using the same device and the same frequency that used in this study (32-36 KHz) but combined with radiofrequency for 5 weeks with session frequency of 1session per week, the duration of cavitation was 20min and low caloric diet that consists of 500 kcal energy deficit per day.

In our study there were no significant difference in body weight and body mass index as weight was maintained by balanced healthy diet consisted of calories equal to the daily caloric needs. That was in agreement with Tonucci *et al. (*2014), Saber *et al. (*2013)*,* Savoia *et al. (2010)* and Jasminka *et al.,* (2010) who achieved significant reduction in localized fat deposits using low frequency ultrasound cavitation with weight maintainance.

While other studies like Mohammadzadeh *et al.* (2015), Sabbour *et al. (*2009) and Elhamd and Elgendy*, (2014)* who approved the efficiency of ultrasound lipocavitation in local fat reduction, achieved also significant reduction in body weight and body mass index. Which may show disagreement with our results, but that have a reason as they use low frequency ultrasound cavitation combined with low caloric diet.

Within the limitation of this study and from the obtained results it could be concluded that Low frequency ultrasonic lipocavitation was effective in improving lipid profile and reducing abdominal localized fat deposits.

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