The photo biological effect of low level laser therapy on serum level of leptin, cholesterol and triglycerides in overweight and obese females

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ABSTRACT

The use of low level laser for body contouring and weight reduction depends on the photochemical non thermal effect of laser light on the adipose tissue. LLLT was reported to liquefy or release stored fat in adipocytes by the opening of specialized yet not identified cell membrane-associated pores after a brief treatment. The concentration of leptin in adipose tissue and serum closely parallel the mass of adipose tissue and adipocyte size and triglyceride content. Thus, leptin increases in obesity and falls with weight loss. The current study was conducted to evaluate the effect of the low level laser therapy (LLLT) on leptin hormone, Cholesterol and triglyceride in both overweight and obese females. Twenty women were included in this study. Their ages ranged from 30-40 years. They were divided into two equal groups. Group A (Overweight group): included 10 females with BMI between 25 and 29.9 Kg/m2 -Group B (Obese group): included 10 females with BMI ≥ 30.

Both groups received LLL to the abdomen using laser scanner for uniform distribution of the beam above and below the umbilicus. Duration of treatment was 30 minutes, 2 times per week for 8 weeks as a total period of treatment. Serum level of leptin was estimated by radioimmunoassay (RIA). As regards serum cholesterol and triglyceride they were determined by enzymatic colorimetric test. Biochemical assessments were done before and after treatment. Results of the present study showed that in the overweight group laser treatment resulted in highly significant reduction in leptin serum level accompanied by highly significant increase in serum triglycerides level. Meanwhile, the increase in cholesterol level was insignificant. As regards the obese group, alteration in serum leptin level caused by laser treatment was not significant. In this group the increase in triglycerides and cholesterol serum levels after treatment were highly significant.

Key words: LLLT, obesity, leptin, RIA, cholesterol, triglycerides.

INTRODUCTION

Human leptin is a protein of 167 amino acids. Leptin is a four-helix bundle with one very short strand segment and two relatively long interconnected loops. This is consistent with a classification as a cytokine four-helix bundle(1). The concentrations of leptin in adipose tissue and serum closely parallel the mass of adipose tissue and adipocyte size and triglyceride content. Thus, leptin increases in obesity and falls with weight loss. These changes are dependent on insulin and glucose (2). Overeating increases serum leptin by nearly 40 percent.
within 12 hours, long before any changes in body fat stores. Conversely, in both normal-weight and obese subjects, fasting reduces serum leptin concentrations by 60 to 70 percent in 48 hours (3).

The concentrations decrease with age in both women and men. Higher serum leptin concentrations are associated with an earlier onset of puberty. Leptin is higher in women, partly due to higher production by SC adipose tissue, stimulation by estrogens, and inhibition by androgens. Pregnant women have higher serum leptin concentrations than non pregnant women. There is a diurnal rhythm of serum leptin concentrations, the values being 20 to 40 percent higher in the middle of the night as compared with daytime (4). Leptin is the primary signal through which the hypothalamus senses nutritional state and modulates food intake and energy balance. The heterogeneous distribution of leptin receptors in extra-hypothalamic brain regions, like cerebellum, cerebral cortex, substantia nigra and hippocampus, suggests that leptin probably modulates neural pathways distinct from those related to body weight regulation. Leptin has been shown to alter the regulation of hormones in the hypothalamus-pituitary-adrenal axis and affects growth hormone. The high sustained concentrations of leptin from the enlarged adipose stores in obese people, results in leptin desensitization (leptin resistance). (5)

Obesity as a disease is a complex interplay of genetic, socioeconomic, and psychological factors. It is associated with an increased basal lipolysis in adipose tissue, elevated circulating FFAs, and is accompanied by abnormalities in both glucose and lipid metabolism (6).

Childhood obesity is a growing and alarming problem associated with several short- term and long-term metabolic and cardiovascular complications. In addition, there is evidence suggesting that excess adiposity during childhood influences growth patterns and pubertal development (7).

LLLT is used to promote tissue regeneration and this type of therapy is based on the stimulatory effects induced by the absorption of a specific wavelength of light by the functioning photo-acceptor molecules (chromophores) (8). LLLT was reported to liquefy or release stored fat in adipocytes by the opening of specialized yet not identified cell membrane-associated pores after a brief treatment (9). Reduction of subcutaneous fat in the thigh of normal women using LLLT was reported by Lach, (10). Diode laser was successfully used for body contouring of the waist, hip and thighs (11) and (12).

Aim of the work:

The objective of this study was to estimate the changes in serum leptin hormone, cholesterol and triglyceride in both overweight and obese females induced by LLLT.

Subjects and methods:

Physical characteristics: Thirty females where included in this study. Age ranged from 30 to 40 years. They were selected from the poly clinic of National Center for Radiation Research & Technology (NCRRRT), Atomic Energy Authority (AER). They were free from any other health problems that may affect the results of the study such as pregnancy, metabolic & cardiovascular diseases, local diseases of the skin, cancer or receive chemotherapy.

The study included two groups:

-Group A (Overweight group): included 10 females with BMI between 25 and 29.9 Kg/m².
- Group B (Obese group): included 10 females with BMI ≥ 30 Kg/m²

**Biochemical assessment:**

**Sampling procedures:**

Blood samples were taken from both groups before laser treatment and two months post treatment. These samples were taken to measure:

1- leptin hormone: serum leptin level was estimated using recombinant human leptin (Leptin-Human Ria-CT) (13)

2- Serum Cholesterol measured according to the methods of Richmoud (14) while triglycerides levels were estimated using the method described by Fossati and Prencipe (15).

**Laser treatment:** The treated groups received transcutaneous low level laser therapy on pared skin (30 minutes per session, 2 times per week for 8 weeks using scanner continuous wave diode laser at wave length 808 nm, dose 10 joule and power 1.6 watt laser dose 10 J. (16)

**Statistical procedures:**

Student (T) test was used to compare between pre & post treatment values within each group and between both groups respectively.

P > 0.05 = Non significant
P < 0.05 = Significant
P < 0.001 = highly significant

The correlation coefficient (r- value):

The correlation between the various parameters estimated in all groups was calculated using the correlation coefficient.

**DISCUSSION**

LLLTT or “cold” lasers use radiation intensities so low so it is thought that any biological effects occur are due to the direct effects of radiation rather than the result of heating. Energies delivered are typically about 10 joules per cm² and using laser operating at powers of 50 mW or less (16). LLLTT was reported to liquefy or release stored fat in adipocytes by the opening of specialized yet not identified cell membrane-associated pores after a brief treatment (9). LLL at the visible and near infrared wave length is absorbed by the cytochrome-c-oxidase unite of the proton transport chain within the mitochondria, intensifying the biological processes to increase hydrogen and calcium ions output. Changes in calcium ions in the cell stimulate the production of a lipase enzyme, which breaks down the enclosed triglycerides into glycerol and fatty acids (11). Compared to the large bulky structure of the stable triglycerides molecule that the body stores the smaller glycerol and free fatty acids are now able to be mobilized through the pores in the wall via transport proteins. Once in the interstitial space they are taken up by the body lymphatic system and transported to the appropriated tissues to be turned into energy during exercise (12).

LLLTT in our study was performed using diode laser which is a cheap, easy to handle and does not produce heat as it depend on the chemical effect and not thermal effect. On the other hand, both conventional liposuction and laser-assisted lipolysis used by DiBernardo etal; 2009 (17), Kolditz and Langin 2010 (18), Wassmer etal; 2010(19), as well as Licataetal;2013 (20) which depend on internal application of laser energy to adipose tissue to induce thermal lipolysis, were more complicated procedures. McBean and Kat 2011(21) stated that thermal injury caused by heat accumulation during laser-assisted lipolysis is considered one of the
serious disadvantages that can cause dermal-epidermal burns and stimulates collagen production (22). Knowledge of the penetration depth of laser radiation in human skin is an essential prerequisite to identifying its method of action. Mathematical simulations and estimates from the literature suggest that the depth of penetration of laser radiation using wavelengths from 630nm up to 1100nm may be up to 50mm. (23).

During the present study LLL of wavelength 808nm was chosen as it penetration depth reach up to the level of subcutaneous fat. One of the areas, which have attracted a great deal of attention, is the role of adipose tissue as a dynamic endocrine organ involved in a wide range of physiological systems and metabolic processes, with extensive cross talk with other tissue and organs (24). Leptin is a 16-Da peptide hormone that is primarily synthesized and secreted by adipose tissue. One of the major actions of this hormone is the control of energy balance by binding to receptors in the hypothalamus, leading to reduction in food intake, elevation in temperature and energy expenditure (25).

In addition, increasing evidence suggests that leptin, through both direct and indirect mechanisms may play an important role in cardiovascular and renal regulation (26).

In response to fasting leptin level fall rapidly before and out of proportion to any changes in fat mass, triggering the neuroendocrine response to acute energy deprivation. In human this response includes decreasing reproductive hormone levels which prevents pregnancy and decrease thyroid hormone that slow metabolic rate (6).

In the present study, the difference in fasting leptin level between the overweight and obese group was considered not significant.

The majority of obese subjects are leptin resistant. The high sustained concentrations of leptin from the enlarged adipose stores result in leptin desensitization, which establishes that obesity is a resultant of hormone resistance rather than hormone deficiency. A key issue for future studies will be to elucidate the molecular mechanisms responsible for leptin resistance (27). Friedman (2011) (28) stated that people who overweight and obese have paradoxically high levels of leptin which means their brains should be telling them to eat less. However, these high levels make them resistant to the effects of leptin.

During the course of the present study laser treatment of the overweight group resulted in high significant reduction in leptin serum level while in the obese group alteration in serum leptin level was not significant.

LLL had been considered one of the recent therapeutic modalities that target the lipolytic pathway and its regulatory mechanisms (9). Transmission electron microscopic images have demonstrated the formation of transitory specialized cell membrane-associated pores in adipocytes followed by collapse of adipose cells after brief treatment with LLL (12).

Adipose tissue lipolysis is a critical pathway for the maintenance of energy homeostasis through the degradation of triglyceride and the release of fatty acid into the circulation (29). During the present study laser treatment caused very significant increase in serum triglyceride level in both studied groups. This increase may be related to mobilization of triglycerides from the adipose cells to the circulation under the effect of laser therapy.

In conclusion, our result indicated that LLLT through decreasing leptin serum level stimulates the brain to respond to the remaining leptin, which is still considered high, with the resultant regulation of both food intake and energy expenditure.
REFERENCE