ORIGINAL ARTICLE

Investigation of the influence of training status on the relationship between the acute exercise and serum leptin levels in obese females

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Abstract

OBJECTIVE: Recent studies have concluded that an energy expenditure by an acute exercise session has no immediate effect on leptin levels while some showed a decline in leptin levels. The purpose of this study was to investigate any possible effects of training status of the subjects on acute exercise-leptin relationship in obese patients.

MATERIALS AND METHODS: Fourteen obese sedentary females were enrolled to the study and effects of acute incremental exercise on serum leptin levels were determined at rest and at maximal exercise performance. Then, they participated to a 12-weeks endurance aerobic training programme performed in the laboratory on a computer controlled cycle ergometer and their leptin levels were re-evaluated and the leptin-acute exercise relationships obtained under different training levels in the same group of subjects were compared. The body compositions were determined by bioelectrical impedance. Pre and post training blood samples were taken at rest and at the maximal exercise performance. Serum leptin levels were analysed in duplicate by RIA. Data were evaluated using, paired t and Pearson's tests.

RESULTS: Leptin levels were not acutely affected by the incremental exercise either before (23.62±3.5 ng/ml and 22.62±3.6 ng/ml) or after (13.13±3.4 ng/ml and 13.82±3.6 ng/ml) endurance training. The marked decrease in leptin levels following training was closely correlated with fat mass loss R= 0.899 (P= 0.0001).

CONCLUSIONS: This study indicates that an increase in energy expenditure by acute exercise has no significant acute effect on leptin level regardless of the training status of the subjects and decrease in leptin levels after a 12-weeks endurance aerobic training programme are closely associated with the fat mass loss.

Introduction

Obesity is a condition of an abnormal body fat mass accumulation and associate with serious medical conditions leading to increased risk of illness, disability and death [1, 2]. Importantly, obesity is an increasingly prevalent health problem. The etiology of obesity is complicated and not well known. It is commonly believed to be results from increases in positive energy due to disrupted balance between energy intake and energy expenditure [3].

Leptin has been identified as an anti-obesity hormone that functions as an afferent signal in a negative feedback regulating body weight through controlling food intake and energy expenditure by affecting the hypothalamic-pituitary-gonadal axis [4]. Besides this well-known function, leptin also has important regulatory affects on body hormonal functions including growth hormone secretion [5], pancreatic beta cell function [6], gonadal function and gestation [7] and placental function [8].

It is commonly accepted that the main determinants of leptin secretion are the net amount of body fat and the mean size of adipocytes [9]. In human subjects, there is a highly significant correlation between leptin and body fat content. A markedly high leptin level has been reported in patients with obesity compared to non-obese individuals [9, 10]. Furthermore, leptin levels are markedly reduced in underweight individuals [11, 12].

It is known that exercise has an important impact on energy expenditure. Considering the role of leptin on energy expenditure, alteration of energy expenditure by an increased physical activity might also influence the leptin levels. Additionally, physical activity is known to have an effect on sympathetic nerve signals [13]. It has been suggested that an increase in sympathetic nerve activity promotes down-regulation of leptin levels [14].

Several investigators reported that an acute exercise has no significant effect on leptin levels in blood taken immediately after exercise [15, 18] or several hours after exercise [19]. In contrary, it has been reported that moderate-intensity exercise was associated with a decline in leptin levels [20, 22]. It may be possible that training status of the subjects contribute to the differences in leptin levels in response to the acute energy expenditure by exercise. However, not much information is available about the effects of training status of the subjects on the relationship of acute exercise and leptin.

In the present study, to explore any possible effect of training status of the subjects on acute exercise-leptin relationship, acute energy expenditure by exercise was performed in obese females and the relationship was examined.

Material and Methods

Subjects

A total of 14 sedentary obese females were participated (age 41±2.7 yr, height 156.7±1.3 cm) in this study. The physical characteristics of the patients before and after the training period are given in Table 1. All patients were medically examined by a physician before they entered the study. They were also screened for taking any medications known to affect body composition. The protocol for this study was approved by local Ethics Committee and informed written consents was obtained from each patient at the start of the study.

Exercise test

All patients started a mild hypocaloric protein enriched diet providing energy approximately 1200–1400 kcal/d, for 12-week study period in addition to a training program.

Each patient performed two incremental exercise tests to exhaustion [23] on a computer controlled, electromagnetically braked cycle ergometer (Lode, Examiner Groningen The Netherlands): one at the onset of the study and one after 12 weeks aerobic training period.

After a warm-up period of 4 min at a power output of 20 W, the workload was increased every minute with a 15 W until the limit of the subject's tolerance. The patients were required to maintain a constant pedalling frequency within the range of 60-80 rpm.

Each subject has also performed a constant load aerobic exercise test 3–4 times per week for approximately 45 minutes in each session using an electromagnetically braked-cycle ergometer under supervision in the Laboratory of Human Exercise Physiology. Training exercise intensity was established using the anaerobic threshold which reflects aerobic to anaerobic metabolic transition point [24] and provide maximal fat oxidation [25].

Table 1: The mean (±SE) values and percent of differences for body mass index (BMI), body weight (BW), fat mass (FM), fat free mass (FFM), leptin and maximal work production capacity (Wmax) at the onset of the study (basal) and at the end of the 12-week aerobic training period.

	Basal	12-wk	% Difference	*P*
BMI (kg/m^2)	40.8±2.1	37.0±2.1	–9.3	P=0.0001
BW (kg)	100.1±4.8	90.8±4.8	–9.3	P=0.0001
FM (kg)	46.4±3.3	38.8±3.5	–17.5	P=0.0001
FFM (kg)	53.7±1.6	51.8±1.4	–3.5	P=0.001
Leptin (ng/ml)	23.62±3.5	13.13±3.4	–44.4	P=0.0001
Wmax (W)	88±7	134±5	52.3	P=0.0001

Body weight and height were measured to the nearest 0.1 kg and 0.5 cm, respectively. Body compositions were assessed at least once every week during 12–weeks therapy period using leg-to-leg bioelectric impedance (Tanita Body Fat Analyser, model TBF 300).

Blood analysis

Blood samples were taken before the exercise (at rest) and at the maximal exercise performance at the beginning and at the end of the 12-week therapy period. After an overnight fasting, blood sample was obtained between 08:00 to 09:00 h always approximately at the same time in the morning to avoid further reduction in leptin over time [26]. Blood sample was taken from the antecubital vein into sterile tube. The tube was centrifuged at 4500 rpm for 10 min at +4 C to obtain serum. The sample was frozen at –20 °C until analysed. Serum leptin levels were measured in duplicate by RIA using commercial kits (Human Leptin RIA, Diagnostic Systems Laboratories, DSL-23100). The limit of sensitivity was 0.1 ng/ml.

Statistic analysis

Data are presented as mean±SE. The data between basal and 12-weeks were compared using paired *t test*. P<0.05 was considered significant. The relationship between fat mass loss and change in serum leptin level was assessed by Pearson's Correlation analysis.

Results

The effects of the 12-week aerobic exercise training program on body compositions are shown in Figure 1. Total body weight and fat mass was decreased over the 12 weeks of aerobic training; from 100.1±4.8 kg to 90.8±4.8 kg (–9.3%) (P=0.0001) and from 46.4±3.3 kg to 38.8±3.5 kg, (–17.5%) (P=0.0001) (Table 1).

The 12-week aerobic exercise training program led to a significant improvement in maximal work production capacity of the subjects, which increased from 88±7 W to 134±5 W, i.e. 52.3% increases (P=0.0001, Table 1).

Figure 2 present the mean (±SE) pre- and post training serum leptin values measured at rest and at maximal exercise performance. The leptin response to the acute exercise did not change significantly when examined before and also after training period. During the incremental exercise test before the aerobic training program, the mean (±SE) serum leptin levels measured at rest and at maximal exercise performance were 23.62±3.5 ng/ml and 22.62±3.6 ng/ml, respectively (P=0.0001). During the incremental exercise test after the 12 weeks aerobic training program, the mean (±SE) serum leptin levels measured at rest and at maximal exercise performance were 13.13±3.4 ng/ml and 13.82±3.6 ng/ml, respectively (P=0.0001). However, exercise training resulted in a marked reduction in leptin levels measured at rest (P=0.0001).

As shown in Figure 3, the decrease of serum leptin level was closely correlated with the body fat mass loss after 12 week aerobic training and correlation was found to be R= 0.899 (P<0.0001). After aerobic training program, the leptin level for each kilogram fat mass and body weight were reduced significantly from 0.5027±0.04 ng/ml/kgFM to 0.3000±0.004 ng/ml/kgFM (i.e. 40% decrease) (P=0.0001) and from 0.2302±0.02 ng/ml/kgBW to 0.1325±0.02 ng/ml/kgBW (i.e. 42% decrease, P=0.0001).

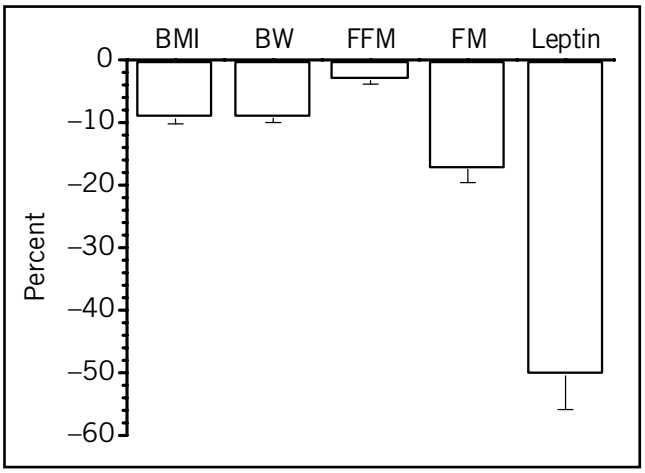

Figure 1: The (mean±SE) percentage change of body mass index (BMI), body weight (BW), fat free mass (FFM), fat mass (FM) and leptin after 12-week aerobic training program.

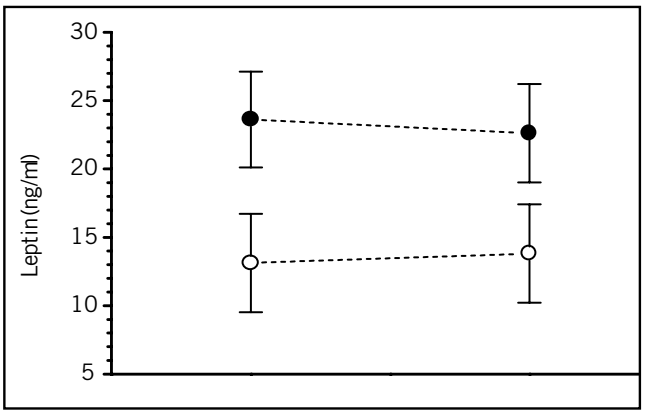

Figure 2: The (mean±SE) values for serum leptin level at rest (W_0) and at maximal exercise performance (W_{max}) before (•) and after 12-week aerobic training period (o).

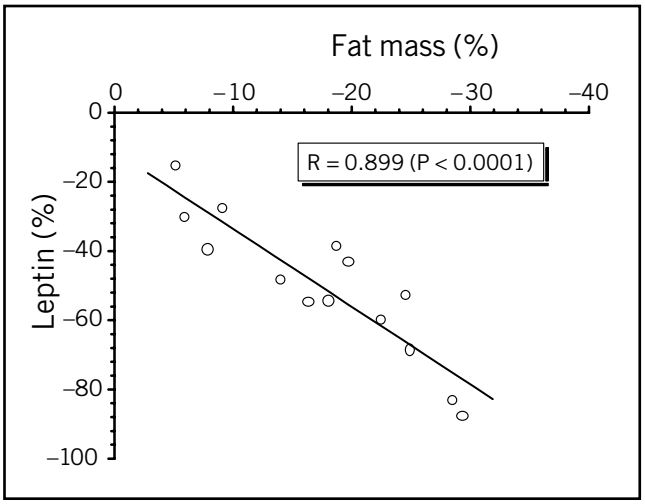

Figure 3: The correlation between fat mass loss and leptin decrease after 12-week aerobic training period.

Discussion

The main result of this study is the independent effect of aerobic exercise training on leptin-acute exercise relationships. Although much research has been conducted investigating the effect of exercise on leptin, to our knowledge this is the first study to examine the effects of training status on the relationship between acute exercise and leptin in obese patients.

The sympathoadrenal system, which has important functions in energy balance could have an effect on leptin [27,28]. However, a single acute exercise has no significant effect on serum leptin levels under the trained condition, which improves sympathoadrenal system. Furthermore, exercise training has been shown to be associated with improvements in glucose tolerance and insulin sensitivity [29] which expect to have an effects of exercise and leptin relationships.

Studies examining the effects of a single acute exercise on leptin levels have resulted with different conclusions. In many studies, using a variety of subjects and exercise bouts, including exercise-trained men completing an endurance bout at moderate intensity [15,17]; sedentary healthy men and women completing a short high-intensity exercise bout [16]; lean and obese men completing an endurance bout at mild intensity 18]; and in untrained men completing a maximal test and an endurance bout of mild intensity [19] showed that exercise has no effects on leptin levels which is in close agreements with the results of our study. In contrast, it should be pointed that a decline in leptin levels in response to the moderate-intensity exercise has been reported in some other studies [20–22].

It is known that variations in the circadian rhythm of leptin may also influence leptin responses to exercise, since it has been demonstrated that the highest concentrations of leptin levels occur between midnight and early morning, followed by a progressive decrease, with the lowest concentrations occurring at noon and in the early-afternoon [30]. In our study, to rule out any influence of the circadian rhythm on the acute exercise blood samples for leptin assays were taken at the same time of the day before and after training.

There are disparate findings concerning exercise training studies, with a number of studies finding no effect of training on leptin concentrations other than effects induced by fat loss, and other studies finding reductions in leptin concentrations after accounting for fat loss. Exercise training-induced reductions in leptin levels have been attributed to alterations in energy balance, improvements in insulin sensitivity, alterations in lipid metabolism, and unknown factors. As associated with the findings of pervious studies, we have found a marked decrease in serum leptin level after 12 weeks aerobic training period [31–33]. The results of this study showed that training may alter leptin levels, although reduced body fat may be responsible for those adaptations [10,34]. There was a negative linear correlation between the amount of fat loss and decrease in leptin levels among the subjects.

Previous studies have shown that aerobic training without effecting body fat mass resulted no change in resting leptin levels of overweight females [35] and non-obese females [16]. However, Hickey et al. [15] have shown a 17.5% reduction in leptin levels in females of normal body weight in response to 12 weeks of training in which body fat did not change.

There was a high percent decreases in leptin level (44.4%) compared to decrease in body weight (9.3%) after 12-week aerobic training period. The observation of high percentage decrease in leptin level compared to the percentage of weight loss was in close agreement with the result of the study of Considine et al. [10] who studied in obese patients and found 53% decrease in leptin as a result of 10% reduction in total body weight by calorie restricted diet (800 kcal/day) application. However, this was disagreement with the results of Wing et al. [36] who found 29% reduction in leptin after 10% weight loss by calorie restricted diet (1200–1500 kcal/day) application. The degree of calorie restriction may have an effect on acute changes in serum leptin [37] but this was not the case in our study group, i.e. during study period, to avoid feeding related change in leptin level a hypocaloric diet therapy was given to all patients.

The roles of exercise, fat metabolism, and leptin are of interest in obesity because those factors can directly affect adipose-tissue mass. A marked increase in whole body lipolytic rate during prolonged moderate intensity aerobic exercise performance has been reported [38]. The high percent reduction in leptin level was considered as a result of high percentage fat mass loss rather than a direct effect of physical exercise itself [16,31]. On the other hand, there is also report that endurance training reduces leptin levels in obese males, independent of body fat [39].

High serum leptin levels are observed in obese patients who have high body fat content, could indicate leptin resistance. In the previous studies, an increase in peripheral leptin resistance as a result of consuming diet containing high fat has been reported in rodents [40,41]. Furthermore a high percentage of increases in leptin levels with increasing body fat mass has been reported [42]. In contrast, decreased leptin levels as a result of lowering body fat mass could restore leptin sensitivity. Thus, the high percentage decreases in leptin levels achieved during 12-week therapy period could have inverse effect on this and may represent a normalisation of leptin function.

In summary, the results from this study suggest that the training status of the subjects has no marked effect on acute exercise-leptin relationship. The decrease in leptin levels after aerobic training is highly correlated with the fat mass loss.

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