Effects of a 3-week integrated body weight reduction program on leptin levels and body composition in severe obese subjects

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ABSTRACT. The effects of short-term (3 weeks) integrated body weight reduction (BWR) program (including energy-restricted diet, aerobic and strength exercise (5 days/week), nutritional education and psychological counseling) on plasma leptin levels and body composition were investigated in 54 morbidly obese patients (38 females/16 males; mean BMI±SE: 41.8±0.1 kg/m², range 35-58 kg/m²; mean age: 29.8±1.0 yr, age range: 18-46 yr). The BWR program induced a significant (p<0.001) weight loss (BMI reduction: -4.8%) and a significant modification in body composition, consisting in a fat mass (FM) decrease (-7.0±0.4%, p<0.001) with a concomitant fat-free (FFM) mass increase (1.8±0.3%, p<0.001). On average, plasma leptin levels decreased significantly both in males (from 19.4±2.6 ng/ml to 11.6±1.3 ng/ml, p<0.001) and in females (from 41.1±3.6 ng/ml to 29.9±3.0 ng/ml, p<0.001). Both before and after weight loss, leptin levels were positively correlated (p<0.001) with BMI and percent fat mass (FM) values. Weight changes after the BWR program were negatively correlated with baseline leptin concentrations both in absolute terms and expressed per unit FM. In conclusion, a short-term diet plus aerobic/strength training effectively induces body composition changes and reduces plasma leptin levels. Body FM reduction appears to be not the unique determinant of leptin levels regulation and the degree of leptin over-expression may negatively affect weight loss in morbidly obese patients.

INTRODUCTION

It is well known that plasma leptin levels, a protein mainly secreted by adipocytes, are significantly correlated with FM in normal weight and obese subjects (1, 2), who display particularly elevated plasma leptin levels (3-6). Moreover, several studies have shown that leptin levels decline with weight loss after a period of energy restriction in both lean (1, 7) and obese subjects (1, 2, 4, 8). Weight loss effects on leptin concentration in obese subjects could be due to different mechanisms, such as a decrease of overall leptin production or an improvement in leptin resistance (9). Due to the general agreement about the positive effect of physical activity in the prevention (10) and treatment (11) of obesity, several investigations in obese patients studied the favorable effects of combining caloric restriction and exercise training on body weight reduction, body composition, and their maintenance over the time (12, 13) as well as on physical fitness and muscle performance (14, 15) and control (16) improvement.

In a relatively small number of investigations the effects of exercise training on leptin levels have been studied in normal subjects (17) or in small groups of overweight or moderately obese patients in the long term (18). In particular, there is relatively scarce information about the influence of the combination of diet and exercise on plasma leptin in severely obese (grade II and III) individuals. Moreover, few data are available on the effects induced by regular, supervised, daily aerobic and strength training exercise (combined...
with energy-restricted diet) on body composition in severely obese patients. The aim of the present study was to verify the effects of a 3-week integrated, hospital-based body weight reduction (BWR) program, consisting of energy-restricted diet, moderate aerobic and strength training exercise, psychological counseling and educational lectures, on leptin levels and body composition, as detected by bioimpedimetry, in a large group of severe obese subjects.

MATERIALS AND METHODS

Subjects

Fifty-four obese patients (38 females/16 males; mean BMI±SE: 41.8±0.1 kg/m², range 35.6-58.3 kg/m²; mean age: 29.8±1.0 yr, age range: 18-46 yr) were admitted to the study after giving their written informed consent. The study protocol was approved by the Ethical Committee of our Institute. Baseline descriptive data for all subjects are shown in Table 1.

None of the patients had significant symptoms or signs referable to acute cardiovascular, orthopedic or neuromuscular disease. Body weight of patients was stable over the previous 3 months and no patient was involved in systematic physical activity before admission. No drugs presently known to interfere with leptin concentration were taken before or during the study. No drugs presently known to interfere with leptin concentration were taken before or during the study.

A group of 36 normal-weight controls with the same male/female ratio (15 males, BMI 21.0±0.5 kg/m² and 21 females, BMI 21.4±0.4 kg/m²) of comparable age (30.2±0.7 yr) was also evaluated.

Body weight reduction (BWR) program

Energy-restricted diet: the BWR program consisted of a 3-week integrated energy-restricted diet (1200-1800 kcal/day), associated with nutritional education, psychological counseling and moderate aerobic exercise (detailed in the following paragraph). The amount of energy to be given with diet was calculated by subtracting approximately 500 kcal from the measurements of basal energy expenditure. The diet contained 21% proteins, 53% carbohydrates and 26% lipids. The daily estimated water content of food was 1000 ml and salt content was 1560 mg Na, 3600 mg K and 900 mg Ca. Fluid intake of at least 2000 ml/day was encouraged. The subjects compliance to diet was daily evaluated by dieticians.

Nutritional education: lectures, demonstrations and group discussions (with or without supervisor) focused on nutritional topics took place daily.

Psychological counseling: the program consisted of 2-3 sessions/week of individual and/or cognitive-behavioral strategies performed by clinical psychologists.

Physical training: the exercise protocol was designed in agreement with the American College of Sport Medicine guidelines (19). As previously described (15) all subjects underwent daily sessions of exercise training for 5 days/week, individually supervised by a certified “personal trainer” and a physician. Heart rate (fh) was recorded with a heart meter-recording device (Polar, Finland), worn by subjects throughout the training sessions. Subjects performed: A) aerobic training consisting, for every session, in 10 min of bicycle ergometer pedaling (50-60 rpm), 20 min of treadmill walking (incline 0-3%) and 5 min of armergometer exercise at an intensity corresponding, for each exercise type, to 50% of individual maximal oxygen uptake (previously determined with the indirect method on a cycloergometer) during the first week of program and 60% in the following two weeks; B) strength training with three isotonic machines (Leg press, Chest press and Vertical traction, Technogym, Italy) for different muscle groups of upper and lower limb, consisting in a single series of 15 repetition at 40% of maximum strength during the 1st week, at 50% during the 2nd week and at 60% during the 3rd week on each machine. The aerobic component of the exercise protocol entailed an average daily expenditure of 267±9.6 kcal during the 1st week, rising up to 331±10.8 kcal in the 3rd week.

No patient dropped out during the 3-week BWR program.

Measurements

All measurements were performed in the morning, after an overnight fast and after voiding, the day before the beginning of the integrated program and repeated at the end of the program (i.e. after 3 weeks).

Weight and height were measured following anthropometric standardization reference manual (20) and BMI (kg/m²) was calculated as the ratio between weight (kg) and height (m) squared. Total body FM and fat-free mass (FFM) were determined by a tetrapolar impedance plethysmograph (Human-IM scan, DS-Medica, Milan, Italy), according to standardized procedures (21). Serum leptin levels were measured by a commercial ELISA kit (DRG Instruments GmbH, Germany); the lowest detectable limit was 1 ng/ml, the inter- and intra-coefficients of variation were lower than 8%.

Statistical analysis

All of the values are given as means ±SE. Average results of the experimental testing observed before and after the program with-