Abstract. Background/Aim: Dermolipectomy dramatically improves the quality of life of previously obese patients. Fat removal in patients undergoing liposuction and reduction mammoplasty has positive effects, but no data regarding sequelae of abdominal dermolipectomy on metabolism have been reported. Thus, the aim of the present study was to assess metabolic and biochemical modifications occurring after abdominoplasty. A correlation between the results and the rate of complications was also evaluated. Patients and Methods: One hundred and twenty-eight patients with body mass index (BMI) between 30 and 35 kg/m² were enrolled. Clinical assessment, anthropometric measurements, blood biochemical analysis (fasting plasma glucose, total cholesterol, free fatty acids, plasma insulin), plasma adipokines (leptin, adiponectin, resistin), levels of inflammatory markers [tumor necrosis factor-alpha (TNFα), interleukin-6 (IL6), C-reactive protein (CRP)] and insulin sensitivity by Homeostasis Model Assessment were performed three times. Results: The average age was 37.6 years. At baseline, the mean (±SD) BMI of patients overall was 33.44 (±2.3) kg/m² and the amount of fat surgically removed was 1,578.33 (±1,013.02) g. A significant decrease in BMI at 1 year was found. Adiponectin levels were found to have significantly increased (p<0.05) in long-term evaluation. We noted significant increases in the mean TNFα (p<0.05), IL6 (p<0.01) and CRP (p<0.05), with a return to baseline values of all variables. The majority of patients were satisfied with the surgical procedure after 12 months. We noted a lower rate (10%) of complications in patients whose blood analysis showed an increase of adiponectin. Conclusion: Abdominal dermolipectomy is a safe surgical procedure that improves the quality of life of previously obese patients from an aesthetic functional view. A statistically significant increase of adiponectin after the procedure was found. A low level of adiponectin after surgery indicates a higher probability of complications.

The worldwide spread of obesity documented by many recent epidemiological studies showed a parallel increase in such complications often referred to as 'metabolic syndrome' (insulin resistance, hypertension, and dyslipidemia) (1). Adipose tissue is a metabolically active tissue (2). Nevertheless, fat cells have both a role in the regulation of inflammatory system and a recognized endocrine action (3). This last aspect is linked to the adipose secretion of several proteins, collectively regarded as 'adipokines' (4). Plasma levels of tumor necrosis factor-alpha (TNFα) and interleukin-6 (IL6) have been shown to increase in human obesity (5), resulting in hyperstimulation of the innate immune system with a subsequent chronic inflammatory state; on the other hand, adiponectin is present at lower levels in obese patients (6), being one of the complex mechanisms involved in the onset of insulin resistance (3).

The role of the plastic surgeon in the improvement of functional aspects linked to massive weight loss (e.g. functional sequelae, aesthetical problems or complaints of dermatitis) (7) is well-recognized. The evidence of the endocrine role played by adipose tissue has raised great debate on the efficacy of plastic surgical procedures of subcutaneous fat removal as a means of improving insulin sensitivity and altering levels of plasma adipokines (8). Dermolipectomy/panniculectomy can be adopted as a first surgical approach for adequately selected obese people with a body mass index (BMI) between 30 and 35 kg/m² who are not candidates for bariatric surgery. Besides its role in body contouring at the end of lengthy bariatric procedures, or after massive weight loss, plastic surgery can be incorporated into a multidisciplinary program of lifestyle changes, allowing these selected obese patients to obtain weight loss and to maintain the reduced weight in the long term (9).
Several previous investigations have focused on the impact of liposuction (2, 8-13), breast reduction (14) and dermolipectomy (8) on metabolic profile and body weight. Although physical improvement and aesthetic benefits of patients undergoing abdominal dermolipectomy are well-recognized, no such data exist on its effects on metabolism. Our study aimed to determine the modifications of weight and of levels of plasma adipokines in mildly obese patients (BMI between 30 and 35 kg/m²) and the correlations between these parameters and the rate of complications after surgical procedure.

**Patients and Methods**

Patients. From January 2008 to January 2010, 128 women undergoing abdominal dermolipectomy with a main central body fat distribution were recruited at the Plastic Surgery Unit of the University of Siena (Italy). These patients all suffered from obesity and had tried for years to lose weight with hypocaloric diet and physical exercise with no relevant results.

Participants were required to have a BMI between 30 and 35 kg/m². Exclusion criteria were heart failure, cardiovascular disease, hypertension, type 2 diabetes, chronic obstructive bronchopneumopathy, connective tissue disease, chronic hepatitis, renal insufficiency and cancer.

All the patients (age range 32-48 years) volunteered for the study, and none of them received drugs. Anthropometric data (height, weight, bioimpedance analysis, digital plicometry), clinical status assessment, blood analysis [fasting plasma glucose (FPG), and insulin, plasma cholesterol and triglycerides, plasma adipokines and inflammatory marker levels] and Homeostasis Model Assessment (HOMA) score (10) were obtained preoperatively (baseline) and then at 6 months (T1) and at 12 months (T2) after the surgical procedure.

All measurements were performed during the follicular phase of the menstrual cycle. To eliminate possible bias due to changes in lifestyle none of the patients followed a particular diet after abdominoplasty(15, 16). At the end of the study 12 months after the surgical procedure, in order to analyse the effect of plastic surgery on quality of life, the satisfaction level was reported by all patients on a scale from 1 (dissatisfied) to 5 (completely satisfied).

All the enrolled patients gave their informed written consent and the study protocol followed the Principles of the Declaration of Helsinki.

**Anthropometric determinations.** Anthropometric parameters such as height and weight by using a standard beam balance and then BMI were first determined. A graduated plastic tape was used to measure waist and hip circumference in the standing position determining waist hip ratio (WHR). Waist circumference was determined at the level of the iliac crest and hip circumference was measured at the trochanter level. Then, in order to determine fat mass and free fat mass, bioimpedance analysis was performed. The procedure of bioimpedance was conducted in an automated manner with Wunder - Body composition analyzer TBF-300 model (Tanita Corporation, Rotherham, Yorkshire, United Kingdom). The machine records the BMI of the patient, the fat mass, lean mass and percentage of water and fat present in the body by metal plates on which the patient rests standing.

**Blood analysis.** Fasting plasma glucose, total cholesterol, triglycerides and free fatty acids (FFA) [according to Dole and Meinertz (17)] were determined by laboratory methods; in addition, serum levels of plasma insulin were obtained. The enzyme-linked immunoassay (ELISA) quantified leptin, adiponectin, resistin, TNFα, IL6 and C-reactive protein (CRP) levels.

**Insulin sensitivity determination.** Besides the determination of fasting plasma insulin, HOMA score was adopted to assess insulin resistance. This index expresses the relationship between the pancreatic secretion of insulin with FPG. This mathematical model allows the estimation of both insulin resistance and the percentage of secretion operated by β-pancreatic cells. A HOMA score greater than 2.4 indicates insulin resistance by the main cells (adipocytes and muscle cells) depending on it for glucose uptake (18).

**Dermolipectomy.** The removal of excess skin and fat from the middle and lower abdomen was performed through a classic transverse abdominal dermolipectomy. This operation was carried out through a long incision from hipbone to hipbone, just above the pubic area, with umbilical transposition and an average cutaneous-adipose mass tissue removal of ~1600 g.

The patients were under total anaesthesia. Patients were mobilized 24 hours following surgery and were discharged after 72 hours with antibiotic therapy (amoxicillin and clavulanic acid, 2 × 1 g tablets per day) for 5 days.

**Statistical analysis.** For all statistical analyses, SPSS for Windows version 13 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism v.5 were used. (GraphPad Software - San Diego, CA, USA).

For all considered variables, data are expressed as the mean and standard deviation (SD) or as absolute frequency and percentage (%). The normality of distributions and homogeneity of variances were tested by Shapiro-Wilk and Levene tests, respectively. The comparisons between times (baseline, T1 and T2) were performed by one-way analysis of variance (ANOVA) for repeated measures and, when necessary, by Bonferroni post hoc test for multiple comparisons. A p-value of less than 0.05 (two-tailed) was considered statistically significant.

**Results**

A total of 64 women were included in the study and completed the follow-up. The mean amount of surgically removed fat was 1,578.33 (±1,013.02) g. The average BMI of these patients at baseline was 33.44 (±1.89) kg/m² and they ranged in age from 32 to 48 years (mean age 37.6-5.4 years). The mean waist circumference at baseline was 112.88 (±21.58) cm and was reduced to 107.63 (±21.68) cm at T2. The metabolic parameters remained constant (p>0.05) throughout the follow-up period; there were statistically significant differences in BMI, particular comparing the baseline value with that at T2 (p<0.05) (Table I).

Table II shows the adipokine levels at each time of follow-up. Even if the observed leptin mean showed a low decrease at T1, persisting at T2, it was not statistically significant (p=0.151). There was a significant difference (p<0.01) in the mean adiponectin level between all times of
follow-up: in particular, statistical increase of this parameter was found between baseline and T1 (p<0.05). A low increase in resistin levels was observed, notwithstanding it not being significant (p = 0.273).

Concerning inflammatory marker levels (Figure 1), there was a significant increase (p<0.01) in mean TNFα between baseline and T1 (p<0.05), with no statistical difference between baseline and T2. Mean IL6 values showed the same trend as those for TNFα since a significant increase was detected between baseline and T1 (p<0.01), although no statistical difference between baseline and T2 persisted. A significant increase of CRP was noted between baseline and T1 (p<0.05) that lost statistical difference at T2.

The administered questionnaire revealed a good patient satisfaction after reconstructive surgery: 82.25% of patients were completely satisfied, 14.62% were satisfied and only one patient (3.13%) was dissatisfied.

Correlations between patients whose blood analysis revealed an increase of adiponectin and those with no significant increase showed a higher percentage of complications (blood transfusion, hospital stay, seroma) in patients with lower levels of adiponectin (90%).

Discussion

Nowadays, obesity represents one of the most relevant problems worldwide, as the latest public health investigations have shown (6). Fat excess is correlated with numerous comorbidities (19-25).

Surgical management of obesity in plastic surgery mainly consists of large superficial fat aspirations or excisions through liposuction (2, 8-13) or dermolipectomies (8, 14). These techniques are likely not only to result in an improvement of anthropometric parameters but they could also induce a favourable change of such metabolic factors. This last aspect seems to be directly correlated to the percentage of body fat mass that is surgically removed (8).

Available evidence provided by recent studies (3-6) asserted that many metabolic parameters are under the influence of a complex network led by what is today called subcutaneous adipose tissue (SAT) (26, 27), whose removal is likely to induce biochemical changes (2, 8, 10-14, 18) with unknown underlying molecular mechanisms. It is also important to underline the key role visceral adipose tissue (VAT) (2, 3, 28) plays in the complex biochemical homeostasis underlying cytokine expression and metabolic regulation of fatty acids.

Results obtained in our study highlighted a statistically significant long-term decrease in BMI that should likely be correlated with a minor incidence of all the obesity-linked metabolic disorders (diabetes and cardiovascular diseases) (29). A significant increase of adiponectin was shown one year from the surgical procedure of panniculectomy; higher blood levels of this cytokine have been correlated with an improvement of obesity-linked chronic inflammatory state and with a minor incidence of metabolic disorders by previous investigations (4-6). We also noted a modification of TNFα, whose hyperexpression is regarded as a marker of

<table>
<thead>
<tr>
<th>Variable (mean value)</th>
<th>Baseline</th>
<th>T1</th>
<th>T2</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>33.44 (±1.89)</td>
<td>32.93 (±1.41)</td>
<td>31.58 (±1.45)</td>
<td>0.019</td>
</tr>
<tr>
<td>HOMA index</td>
<td>3.60 (±2.28)</td>
<td>2.87 (±1.23)</td>
<td>3.42 (±1.68)</td>
<td>0.657</td>
</tr>
<tr>
<td>FPG (mg/dl)</td>
<td>82.84 (±3.51)</td>
<td>85.00 (±11.98)</td>
<td>91.25 (±7.46)</td>
<td>0.123</td>
</tr>
<tr>
<td>Plasma triglycerides (mg/dl)</td>
<td>132.60 (±38.18)</td>
<td>123.80 (±3.15)</td>
<td>110.00 (±12.07)</td>
<td>0.189</td>
</tr>
<tr>
<td>Plasma total cholesterol (mg/dl)</td>
<td>180.60 (±30.60)</td>
<td>157.30 (±24.88)</td>
<td>167.8 (±38.13)</td>
<td>0.167</td>
</tr>
<tr>
<td>Plasma insulin (mU/l)</td>
<td>16.77 (±12.36)</td>
<td>13.25±(3.81)</td>
<td>15.11 (±7.12)</td>
<td>0.480</td>
</tr>
</tbody>
</table>

BMI: Body mass index; HOMA: Homeostasis Model Assessment; FPG: fasting plasma glucose. T1: 6 months after dermolipectomy; T2: 12 months after dermolipectomy; p<0.05: baseline versus T2. Data expressed as means.

Table II. Adipocytokine levels in the follow-up period.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>T1</th>
<th>T2</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leptin (mg/ml)</td>
<td>31.96 (±18.46)</td>
<td>27.81 (±16.91)</td>
<td>28.56 (±19.61)</td>
<td>0.214</td>
</tr>
<tr>
<td>Adiponectin (µg/ml)</td>
<td>8.11 (±4.43)</td>
<td>9.09 (±5.34)</td>
<td>9.31 (±5.00)</td>
<td>0.457</td>
</tr>
<tr>
<td>Resistin (ng/ml)</td>
<td>4.54 (±5.24)</td>
<td>7.51 (±12.35)</td>
<td>4.83 (±4.03)</td>
<td>0.498</td>
</tr>
</tbody>
</table>

T1: 6 Months after dermolipectomy; T2: 12 months after dermolipectomy. p<0.05: baseline versus T2. Data are expressed as means±SD.
chronic inflammation (3, 5, 28). This cytokine would play a determinant role in dysregulation of adipocyte-regulated endocrine homeostasis and could even be involved in the genesis of insulin resistance (5). Thus, a statistically significant change in the level of this molecule is correlated with a reduction of the chronic inflammatory state as a consequence of adipose tissue hypertrophy and 'dystrophy' (3, 6, 8, 9). A similar trend was observed for the change of IL6, whose production depends on many cell types (fibroblasts, endothelial cells, monocytes); this cytokine is overproduced in obesity and represents an important link between obesity, inflammation and insulin resistance (3, 30, 31). A significant increase of adiponectin was also found: this molecule seems to counteract the metabolic actions of TNFα and IL6 (4, 8, 32, 33). Nevertheless, adiponectin is an adipocyte-derived plasma protein with insulin-sensitizing, anti-inflammatory and anti-atherogenic properties, negatively correlated with obesity (6, 32). On the other hand, high plasma levels of TNFα and IL6 are found in obese patients and have effects both on the reduction of adiponectin mRNA expression and on the insulin signalling pathway (26). Most studies have shown that fat removal produces beneficial effects on insulin resistance, evidenced in the subclinical inflammatory condition linked to obesity (8, 9).

Obviously, further studies would be necessary to better understand the biological function of adipokines and it would be important to increase the size of the population studied. However, in our investigation, the analysis of molecules previously cited allowed us to appreciate the changes of the cross-talk between fat and metabolic tissues after SAT excision.

Conclusion

Our study demonstrates that dermolipectomy performed in obese patients with BMI between 30 and 35 kg/m² results in a change of plasma adipokines probably linked to an improvement of insulin sensitivity without supportive programs such as diet or exercise. Further long-term studies in larger populations are still necessary to determine if this surgical procedure is directly correlated with a reduced incidence of type 2 diabetes and cardiovascular disease.

Conflicts of Interest

None. The Authors declare that they have no conflict of interest.

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Received August 25, 2015
Revised October 8, 2015
Accepted October 12, 2015