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Body Contouring

Preliminary Report

Impact of Large-Volume Liposuction on Inflammatory Cytokine Interleukin-6 Levels: A Cross-Sectional Study

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Abstract

Background: Liposuction is a widely performed surgical procedure for fat removal, showing increasing popularity for body sculpting purposes. Surgical interventions typically trigger an inflammatory response, but in the context of overweight and obesity, excess adipose tissue can perpetuate systemic inflammation. Adipose tissue, recognized as an endocrine organ, secretes adipokines, influencing metabolic and inflammatory processes. Interleukin-6 (IL-6) is a key cytokine involved in inflammation, notably elevated in obese individuals.

Objectives: The aim of this study is to understand the impact of liposuction on IL-6 levels and its correlation with different follow-up points.

Methods: This cross-sectional study involved patients undergoing liposuction between January and December 2023. Exclusion criteria included metabolic or chronic diseases. IL-6 levels were measured preoperatively and at 1, 3, and 6 months postsurgery. Data on liposuction volume, BMI, and demographic variables were collected.

Results: Twenty-seven patients participated, predominantly female (21/6) with a mean age of 36.42 years. Significant reductions in BMI were observed postoperatively, with a notable increase in IL-6 levels immediately postsurgery followed by a decline at 1 month. IL-6 levels remained stable and were significantly lower than the baseline preoperative levels on the third and sixth follow-up visits.

Conclusions: Liposuction induces a temporary inflammatory response, as evidenced by elevated IL-6 levels postsurgery, which subsequently normalize within the first month. Although liposuction may offer short-term improvements in inflammatory response, larger studies are needed to understand its long-term impact on inflammation and metabolic health.

Level of Evidence: 2 (Risk)

Liposuction is among the most commonly performed surgical procedures globally, with an incidence rate of 24.8% and a growing trend.[1] Although it was traditionally used to remove excess fat from areas like the waist, abdomen, hips, and buttocks, it is now also applied for smaller scale fat removal and body sculpting, including procedures targeting the neck and chin. On the other hand, the American Society of Plastic Surgery defines an aspirate volume >5 L as large-volume liposuction.[2]

All surgical procedures induce an inflammatory response in the body, evidenced by elevated levels of acute inflammatory markers, like C-reactive protein (CRP), white blood cell count, and cytokines.[3] These levels tend to decrease as the healing process progresses. However, excess weight and fat-tissue accumulation are also associated with an inflammatory state and oxidative stress in the organism, driven by various mediators and biological pathways.

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Table 1. Demographic and Intraoperative Variables of the Study Group

Variables	Baseline
Age (years)	36.42 ± 5.14
F/M	21/6
Aspirated fat volume (mL)	3943 ± 1524
Tumescent solution volume (mL)	7358 ± 2354

Recently, adipose tissue has been recognized as an endocrine organ owing to its ability to produce adipocytokines, proteins related to the obesity-associated complications.[4,5] Moreover, elevated levels of several cytokines and CRP in circulation have also been linked to an elevated risk of cardiovascular disease and thrombotic cardiovascular incidents.[6,7]

It has been suggested that weight loss leads to alterations in inflammatory status and adipokine levels.[8,9] Therefore, reducing adipose tissue through liposuction might impact adipokine secretion and subsequently influence the metabolic profile.

Interleukin-6 (IL-6) is a 184–amino acid protein cytokine that serves as an acute mediator during the inflammatory response, exhibiting a rapid surge following injury to the body.[10]

IL-6 is generated by numerous cell types and is released in reaction to different forms of cellular stress, including inflammation, infection, and cancer. Surgical procedures have been demonstrated to increase circulating IL-6 levels, correlating with the extent of surgical stress.[11]

Hence, the aim of the present study was to investigate the role of liposuction on IL-6 levels on different time points, and its correlation with the preoperative and postoperative weight and obtained adipose-tissue volume.

METHODS

Study Design and Population

This is a cross-sectional study of patients that was conducted at a single plastic surgery clinic. Patients who underwent liposuction and volunteered for the study between January and December 2023 were included.

Inclusion criteria were as follows: aged 18 years or older, willing for the testing of IL-6 on the study follow-up points, and patients who underwent a primary liposuction procedure. The patients with a metabolic disease, obesity, hypertension, chronic or autoimmune disease, and patients who underwent a previous bariatric surgery procedure were excluded.

Study variables were age, gender, serum IL-6 levels, and BMI. IL-6 levels were analyzed on the predetermined follow-up points: preoperative, after the surgery, on the first, third, and sixth months postsurgery.

Informed consent was obtained, and the study was conducted in accordance with the Declaration of Helsinki.

Height and weight measurements were collected with participants wearing light clothing and no shoes, using the same scale for all measurements. BMI was calculated as weight in kilograms divided by the square of height in meters.

Table 2. Comparison of Study Variables on the Follow-up Points

Variables	Mean ± SD	*P*-value[a]	*P*-value[b]
BMI (kg/m^2)			
Preoperative	28.14 ± 5.46	<.001	.381
Postoperative	25.76 ± 2.99	<.001	.217
Postoperative first month	25.58 ± 2.28	<.001	.284
Postoperative third month	23.44 ± 1.89	<.001	
Postoperative sixth month	24.75 ± 3.08		
IL-6 (pg/mL)			
Preoperative	6.301 ± 9.466	.0002	<.0001
Postoperative	27.57 ± 12.08	.3804	.4034
Postoperative first month	3.349 ± 1.739	.043	.2327
Postoperative third month	2.423 ± 1.058	.031	
Postoperative sixth month	2.375 ± 0.035		

IL-6, interleukin-6.[a]Difference with preop.[b]Difference with previous measurement.

Standard, ultrasound-assisted liposuction, using a tumescent solution, was performed under general anesthesia. Liposuction was performed in 1 or more anatomical sites, including abdomen, hips, waist, and thighs. The volumes of fat aspirated and tumescent solution used were quantified and recorded.

Venous blood samples for IL-6 analysis were stored at 2°C to 8°C and transported to the laboratory within the same day of sampling while maintaining a cold chain. Serum concentrations of IL-6 were measured using the e UniCel Dxl 800 Product Access IL-6, Interleukin-6 Reagent Pack assay (Beckman Coulter, Inc., Brea, CA).

Statistical Analysis

Categorical variables were presented as frequency and percentages, whereas numerical variables were presented as mean ± standard deviation. A paired Student's *t* test was used for the comparison of variables between follow-up time points. A Pearson's correlation coefficient analysis was performed between the study variables. Analysis was performed using the IBM SPSS software version 17.0 (IBM Corp., Armonk, NY). A *P* value <.05 was determined for the statistical significance.

RESULTS

A total of 27 patients were included in the study, with a mean age of 36.42 ± 5.14 years, and female-to-male ratio of 21/6. The mean aspirated fat volume at the surgery was 3943 ± 1524 mL, whereas the mean volume of tumescent solution used was 7358 ± 2354 mL (Table 1).

None of the patients developed a postoperative complication which would affect the inflammatory status.

IL-6 and BMI levels were measured before surgery and at 1, 3, and 6 months after surgery (Table 2, Figure 1). A significant reduction in BMI was observed at all postoperative intervals compared with

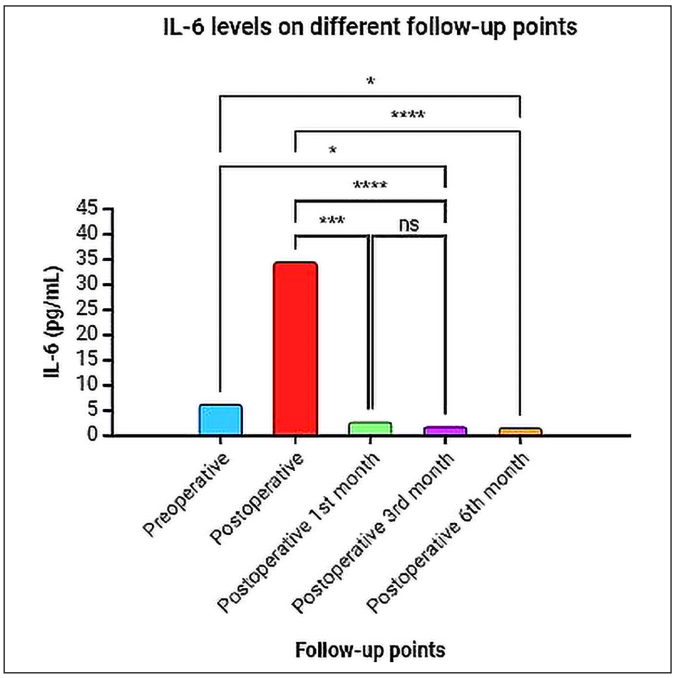

Figure 1. Comparison of IL-6 levels on the follow-up points. IL-6, interleukin-6.

preoperative levels, but there were no significant differences when comparing BMI across the different postoperative follow-ups.

IL-6 levels showed a marked increase immediately after surgery compared with the baseline. The levels then significantly decreased by the first-month follow-up visit. When comparing the IL-6 levels between the first-, third-, and sixth-month follow-up points, significant differences were found on the postoperative third and sixth month.

The correlation matrix table presents correlations between various variables measured in the study. These variables include preoperative and postoperative IL-6 levels, preoperative weight and BMI, postoperative weight and BMI at the first month, liposuction volume, and tumescent solution volume.

The correlations between the study variables were presented in Table 3. Postoperative IL-6 levels were strongly positively correlated with liposuction volume ($r = 0.812$). Preoperative BMI showed strong positive correlations with preoperative weight ($r = 0.837$), postoperative first-month weight ($r = 0.822$), and postoperative first-month BMI ($r = 0.995$). Liposuction volume had moderate positive correlations with preoperative BMI ($r = 0.646$), postoperative first-month BMI ($r = 0.599$), and tumescent solution volume ($r = 0.705$). Tumescent solution volume correlated moderately positively with preoperative BMI ($r = 0.681$) and postoperative first-month BMI ($r = 0.631$).

IL-6 levels did not significantly correlate with weight or BMI measures.

DISCUSSION

To the best of our knowledge, this is one of the limited number of studies investigating the impact of liposuction on inflammatory cytokine IL-6 levels. According to our findings, starting from the postoperative first month, IL-6 levels decreased and stabilized, with a significant decrease compared with the preoperative baseline levels. This suggests liposuction induced a transient postoperative inflammatory response as reflected by elevated IL-6 that subsequently resolved within the first postoperative month. Furthermore, both BMI and IL-6 trends suggest that stable metabolic inflammatory outcomes were attained by the first month following liposuction.

Similar to postsurgery, IL-6 concentrations also increase in sepsis, correlating with the severity of the illness and predicting negative outcomes. Moreover, in a recent study, Zhang et al reported that elevated IL-6 levels at the sixth hour after surgery are strong predictors of postoperative cognitive dysfunction.[12] In our cohort, all patients exhibited significantly elevated levels compared with baseline, with values surpassing the 6.4 pg/mL threshold by up to 4- to 5-fold.

Lubkowska and Chudecka investigated the impact of small-volume liposuction on metabolism markers in a group of 27 women.[13] Following the procedure, changes in body composition and adiposity indicators were observed, along with a slight reduction in adiponectin, leptin, resistin, insulin levels, and HOMA-IR value, whereas the lipid profile remained unchanged. Their findings suggest that small-volume liposuction in the gluteal-femoral region may have a positive effect on carbohydrate and lipid metabolism, potentially lowering the risk of insulin resistance. Although the procedure did not target abdominal adipose tissue directly, the reduction in fat from the gluteal and femoral areas appeared to mitigate the risk of insulin resistance and obesity. We suggest that an ameliorated metabolic balance in the organism might be reducing the inflammatory response as indicated by the observed decline in IL-6 levels postprocedure in our study group. Furthermore, the IL-6 levels of patients were lower than the baseline levels starting from the postoperative third month, which further supports this hypothesis.

Similar to our study, Giugliano et al investigated the effects of liposuction on insulin resistance and inflammatory markers in obese individuals.[14] When they compared 30 obese and 30 normal-weight women for insulin sensitivity and inflammatory markers, such as IL-6, IL-18, and tumor necrosis factor-alpha, they found that obese women exhibited improvements in insulin resistance and reductions in inflammatory markers following the procedure. The volume of fat removed correlated with changes in insulin resistance and inflammatory markers. In our study, we observed a correlation between the lipoaspirate volume and postoperative IL-6 levels in our study group.

Some authors consider that obesity is responsible for the maintenance of a subclinical inflammatory state, perpetuated by the adipokines.[15] Despite its potential benefits in reducing cardiovascular risk, hypertension, and insulin resistance, liposuction has not been widely adopted as a standard treatment for obesity.

In women who underwent liposuction, Chang et al monitored a panel of inflammatory markers at 3 distinct time points: before the procedure, 1 day after liposuction, and 1 month postsurgery. They found that IL-6, high-sensitive CRP, and serum amyloid-A exhibited an acute response, peaking 1 day after liposuction.[16] However, these proinflammatory cytokines and acute-phase reactants returned to baseline levels by the 1-month postsurgery. They state that the acute inflammatory response observed does not progress to oxidative stress typically associated with chronic inflammation.

It is widely known that the adipose-tissue volume of women is greater compared with men because of the stimulating effect of estrogens on the replication of adipocytes.[17] The adipose-tissue content consists of connective tissue, adipocytes, blood vessels, nerves, fibroblasts, and preadipocytes, which are disrupted by the

Table 3. Correlation With the Weight Change and IL-6 Levels

	Preoperative IL-6	Postoperative IL-6	Postoperative first-month IL-6	Postoperative third-month IL-6	Postoperative sixth-month IL-6	Preoperative weight	Preoperative BMI	Postoperative first-month weight	Postoperative first-month BMI	Liposuction volume
Preoperative IL-6	1.00									
Postoperative IL-6	0.006	1.00								
Postoperative first-month IL-6	−0.289	−0.382	1.00							
Postoperative third-month IL-6	0.0303	0.0152	0.019	1.00						
Postoperative sixth-month IL-6	0.091	0.0131	0.057	0.041	1.00					
Preoperative weight	−0.162	0.186	−0.402	0.089	0.097	1.00				
Preoperative BMI	−0.221	0.337	−0.414	−0.179	−0.085	0.837[a]	1.00			
Postoperative first-month weight	−0.176	0.165	−0.401	0.267	0.012	0.998[a]	0.822[a]	1.00		
Postoperative first-month BMI	−0.24	0.309	−0.423	−0.087	−0.082	0.876[a]	0.995[a]	0.864[a]	1.00	
Liposuction volume	−0.09	0.812[a]	−0.421	−0.332	−0.247	0.296	0.646[a]	0.268	0.599[a]	1.00
Tumescent solution volume	−0.186	0.30	−0.059	−0.318	−0.216	0.258	0.681[a]	0.234	0.631[a]	0.705[a]

IL-6, interleukin-6. [a]$P < 0.05$.

suction effects of liposuction cannulas during the procedure. We suggest that the acute elevation in IL-6 levels during the initial postoperative phase could be attributed to both the mechanical impact of the procedure on adipocytes and the surgical stress.

Taking into consideration that IL-6 is also secreted by adipocytes, as well as the macrophages in the stroma, adipose tissue participates in complex crosstalk pathways. The positive correlation between the circulating IL-6 levels and adiposity has already been reported in human populations, with increased levels of IL-6 in obese patients, whereas weight loss leads to a reduction in IL-6 levels.[18,19] Also, research indicates a decline in immune cell populations during calorie restriction. Unlike the classic inflammatory response triggered by infection, the inflammatory response in case of the presence of excess adipose tissue and obesity, termed meta-inflammation, is initiated by intrinsic signals, and endoplasmic reticulum stress through the activation of the nuclear factor-kappa B–signaling pathway.[20] This process leads to the production of proinflammatory cytokines, reactive oxygen species, and proinflammatory adipokines by adipocytes and immune cells within adipose tissue. Thus, adipokines play a significant role in modulating the inflammatory response in adipose tissue during obesity development and in response to infection or systemic inflammation.

Research has demonstrated that also the hypertrophied adipocytes exhibit increased expression of inflammatory genes, which can contribute to the harmful accumulation of fatty acids in the liver and muscles.[21,22] A subcutaneous liposuction may additionally modify the proportion of visceral adipose tissue, thereby improving the metabolic profile of individuals. However, we did not employ metabolic risk profiling in the context of this study, and the initial postoperative rise in IL-6 levels are considered to be because of the effects of surgery. However, 9 out of 27 patients (30.0%) in our study group had baseline IL-6 levels surpassing clinical cut-off points. However, following surgery, IL-6 levels remained below the threshold for all individuals across all time points, which may further support the link between lipid accumulation and inflammation. In the context of this study, we did not include individuals with obesity, and all cases had a BMI <30 kg/m^2. Nevertheless, even in this context, removal of adipose-tissue content by liposuction was linked to the improvement of the inflammatory status.

Our study has several limitations to declare. Firstly, we focused solely on IL-6 as an inflammatory marker, and other acute-phase reactants or several indicators of oxidative stress were not included in this research. Additionally, the sample size was relatively small, and our findings are restricted to the effects of liposuction. Furthermore,

gender is a possible confounding variable/limitation of the study, because women have greater adipose tissue than men. However, our study contributes to the limited body of research investigating the impact of liposuction on inflammatory cytokine IL-6 levels, particularly in relation to surgical stress.

CONCLUSIONS

Our findings suggest that liposuction induces a transient postoperative inflammatory response, as evidenced by elevated IL-6 levels that subsequently decline and stabilize within the first-month postsurgery. Overall, although liposuction may offer improvements in inflammatory response, further research with large cohorts are needed to fully elucidate its long-term effects.

Disclosures

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