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Suction-assisted lipectomy fails to improve cardiovascular metabolic markers of disease: A meta-analysis



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Liposculpture;
Lipoplasty;
Cardiovascular

Summary *Background:* The purpose of this study was to determine whether suction-assisted lipectomy (SAL) decreases the incidence of early cardiovascular disease risk factors or its biochemical and clinical risk indicators.

Methods: A systematic review of the literature was performed by conducting a predefined, sensitive search in MEDLINE without limiting the year of publication or language. The extracted data included the basal characteristics of the patients, the surgical technique, the amount of fat extracted, the cardiovascular risk factors and the biochemical and clinical markers monitored over time. The data were analysed using pooled curves, risk ratios and standardised means with meta-analytical techniques.

Results: Fifteen studies were identified involving 357 patients. In all of the studies, measurements of predefined variables were recorded before and after the SAL procedure. The median follow-up was 3 months (interquartile range (IQR) 1–6, range 0.5–10.5). The mean amount of extracted fat ranged from 2063 to 16,300 ml, with a mean \pm standard deviation (SD) of 6138 ± 4735 ml. After adjusting for time and body mass index (BMI), leptin and fasting insulin were the only markers that were significantly associated with the amount of aspirated fat. No associations were observed for high sensitive C-reactive protein (hCRP), interleukin-6 (IL-6),

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adiponectin, resistin, tumour necrosis factor- α (TNF- α), Homeostasis Model of Assessment (HOMA), total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides, free fatty acids or systolic blood pressure.

Conclusions: Based on the results of our analysis, we conclude that there is no evidence to support the hypothesis that subcutaneous fat removal reduces early cardiovascular or metabolic disease, its markers or its risk factors.

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Since Illouz¹ reported the aspiration of subcutaneous adiposity using blunt cannulas in the early 1980s, liposuction has gained wide acceptance and popularity. However, the physiologic consequences of suction-assisted lipectomy (SAL) are poorly understood. Large-scale studies assessing the impact of SAL on cardiovascular (CV) events have never been performed, but there are increasing reports of the possible beneficial effects of SAL on CV disease risk factors (RFs).² Consequently, it is reasonable to suggest that fat tissue removal could decrease the incidence of CV disease, type 2 diabetes mellitus (DM) or metabolic syndrome.

The objective of our study was to determine whether SAL decreases the incidence of CV RFs or reduces its biochemical and clinical risk indicators. We conducted a systematic review of the literature and performed a meta-analysis of published studies addressing this topic.

Methods

Inclusion criteria

Criteria for considering studies for this review

Human studies with a cohort-type design in which the appearance of CV disease or its early markers or RFs were measured before SAL and at least once 1 month following the surgery were included.

Types of participants

Human subjects of any gender, weight or race comprised the study.

Types of interventions

Any lipectomy procedure assisted by suction, LASER or ultrasound, excluding direct lipectomy, performed for abdominoplasty or body lift applications was included.

Outcome measures

We did not pre-define the early markers of CV risk because there are many markers used in the literature. The markers chosen by the authors of the selected studies were extracted and analysed, if feasible.

Search methods for the identification of studies

Electronic searches

The studies in MEDLINE were searched using the PubMed (<http://www.pubmed.com>) interface with no date or

language restriction. A MeSH term for lipectomy was used; also, the search was limited to human studies and clinical trials or randomised controlled trials. The search date was 27 July 2012, and the keyword and strategy are depicted in Figure 1.

Searching other resources

The references of the selected studies were searched manually and retrieved in full-text format whenever possible.

Data collection and analysis

Selection of studies

The identified studies were independently selected based on the title and abstract by two of us (SD and CL); disagreements were resolved by consensus.

Data extraction and management

The data were extracted from the retrieved studies. We classified the variables into four categories:

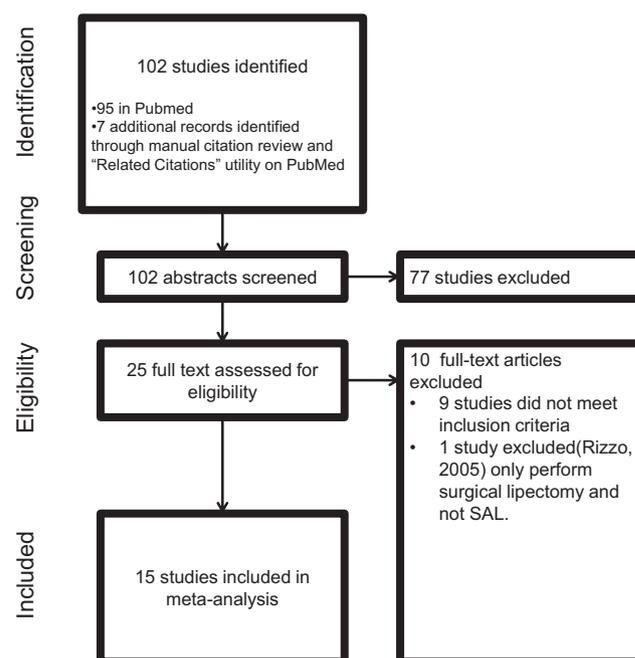


Figure 1 Search strategy. PubMed Keyword: "Lipectomy" [Mesh] AND ("humans" [MeSH Terms] AND (Clinical Trial [ptyp] OR Randomised Controlled Trial [ptyp])).

Table 1 Summary of selected articles.

Author, year	Patients (males/females)	Follow-up (mean) (months)	Relevant outcome measurements	Mean aspirated volume (mL)	BMI (mean)	Major authors conclusions
Ybarra 2008	2/18	4	hCPR, Adiponctin, APO-B, APO-AI, APO-AII, glucose, HOMA, cholesterol, triglycerides, BP, waist circumference	5494	25.3	Abdominal liposuction in healthy normal weight or slightly overweight subjects improves the major lipoprotein components of obesity-associated dyslipidemia. This improvement occurs independent of insulin sensitivity.
Busetto 2008	0/15	6	hCPR, IL-6, Leptin, adiponectin, resistin, glucose, HOMA, FFA, insulin, REE	16300	37.5	In the later recovery phase, we registered a reduction of leptin levels consistent with the fat mass loss and a small improvement of insulin resistance. The reduction of leptin concentrations was associated to a lower resting energy expenditure.
Robles-Cervantes 2007	0/6	6	Leptin, TNF- α , glucose, cholesterol, triglycerides, BP	4582	31.9	Subcutaneous abdominal fat correlates with leptin; nevertheless, it is a weak marker for TNF- α and insulin sensitivity.
Chang 2007	0/15	1	hCPR, IL-6, SAA, Leptin, Adiponectin, No, Nitrotyrosin, microalbumin, 8-OHdG/creatinin	NA	<25	Apparently the impact of liposuction for normal subjects did not advance beyond acute inflammatory response
Hong 2006	1/10	2	Cholesterol	6790	23.8	Large-volume liposuction reduced weight and total cholesterol level and increased the HDL/LDL ratio
D'Andrea 2005	0/123	3	IL-6, IL-10, Leptin, adiponectin, resistin, TNF- α , glucose, cholesterol, triglycerides, FFA, BP, wais/hip ratio, RQ	NA	32.8	Large-volume liposuction resulted in a significantly improved insulin sensitivity, resting metabolic rate, serum adipocytokines, and inflammatory marker levels
Giugliano 2004	0/60	6	hPCR, IL-6, IL-18, Adiponectin, TNF- α , glucose, HOMA, cholesterol, triglycerides, waist/hip ratio, insulin	3540	28.8	SAL is associated with amelioration of insulin resistance and reduced circulating markers of vascular inflammation
Klein 2004	0/15	3	hCPR, IL-6, SAA, Leptin, adiponectin, TNF- α , glucose, cholesterol, triglycerides, BP, waist circumference	16,466	37.3	Abdominal liposuction does not significantly improve obesity-associated metabolic abnormalities
Robles-Cervantes 2004	0/15	0.75	Glucose, HOMA, cholesterol, insulin	3570	26.3	Liposuction is a safe surgical procedure from a metabolic point of view because it improves the levels of cholesterol, glucose, and insulin secretion and at the same time decreases adiposity.
González-Ortiz 2002	0/12	1	Glucose, HOMA, cholesterol, triglycerides, BP, REE, RQ, triglycerides, insulin	NA	31.7	Large volume SAL led to an improvement in insulin sensitivity and a decrease in glucose concentration
Giese 2001	0/14	4	Glucose, HOMA, cholesterol, triglycerides, BP, REE, RQ.	9406	29.1	Large-volume liposuction decreased weight, body fat mass, systolic blood pressure, and fasting insulin levels without detrimental effects on lean body mass, bone mass, resting energy expenditure, or lipid profiles
Chen 2001	0/4	0.5	Leptin, waist/hip ratio	NA	NA	Plasma leptin levels markedly decreased, and the decrease lasted for at least 14 days after suction lipectomy

(continued on next page)

Table 1 (continued)

Author, year	Patients (males/females)	Follow-up (mean) (months)	Relevant outcome measurements	Mean aspirated volume (mL)	BMI (mean)	Major authors conclusions
Talisman 2001	0/22	1.5	Leptin	2947	27.3	A reduction of the peripheral fat content of more than 2700 ml by SAL has an immediate effect on leptin levels that lasts at least 1 week and correlates with voluntary changes in energy intake.
Baxter 1997	0/10	2	Cholesterol	3127	NA	Fat reduction by SAL affects fasting serum cholesterol levels
Samdal 1995	0/9	10.5	APO-B, APO-AI, glucose, HOMA, cholesterol, triglycerides, FFA, insulin	3633	30.1	A significant increase in HDL cholesterol and apolipoprotein A1, while there was no significant change in sex hormones or glucose levels 9–12 months after the liposuction procedure

hPCR = High sensitive C-reactive protein; SAA = serum amyloid A; HOMA = Homeostasis model assessment; BP = Blood pressure; REE = Resting energy expenditure; RQ = Respiratory quotient; TNF- α = Tumor necrosis factor-alpha.

- 1) Study variables: main author, year of publication, sample size and risk of bias.
- 2) Outcome variables (early markers for CV disease): waist circumference, blood pressure, plasma glucose, plasma insulin, cholesterol (total, low-density lipoprotein (LDL) and high-density lipoprotein (HDL)), triglycerides, leptin, adiponectin, tumour necrosis factor- α (TNF- α), interleukin-6 (IL-6), high sensitive C-reactive protein (hCRP), Homeostasis Model of Assessment (HOMA) index (fasting plasma insulin (micro-international units per millilitre) \times fasting plasma glucose (millimoles per litre)/22.5).^{3,4}
- 3) Main independent variable: amount of fat removed.
- 4) Control variables: time effect and body mass index (BMI).

All units were converted to the metric system, and the same unit was used for each variable before the analysis.

Assessment of the risk of bias in the included studies

The risk of bias was assessed using the criteria suggested by Sackett⁵ for prognostic studies, such as the length of follow-up, attrition bias (loss >20% of the cohort) adequate description of variables and description of the co-interventions.

Statistical analysis

As a measure of efficacy, we used the variations in the above-mentioned outcome variables. The change in a given variable was attributed to SAL if the magnitude of the variation was correlated with the amount of fat extracted, was independent of the body weight and was consistent within each study (fixed effect and time effect) and between studies (random effect). Each variable was adjusted according to the statistical weight of the study. To address all of these variables at once, we chose a mixed model approach.⁶ All the variables were controlled by the time effect and assessed for fixed and random effects using the inverse of the variance ($1/S^2$) as a precision measurement. In this manner, each of the meta-regression models shared the common structure:

$$y = \text{Outcome Measure} + \text{Time Effect} + 1/S^2[\text{Outcome Measure}] + \text{BMI} + \text{RemovedFAT}$$

The mean value of the variable was used as the outcome measurement indicator for each study. The BMI was retrieved from the reported data or calculated data based on height and weight. The mean value of the fat removed was used, except in studies that only reported the total volume extracted. In these cases, the mean volume was estimated as two-thirds of the total aspirated volume (mean ratio of included studies).

For the description of the variables, the mean \pm standard deviation (mean \pm SD) was used for continuous outcomes; the median (p50) and range were used for ordinal variables, and frequencies and percentages (n , %) were used for categorical variables unless otherwise stated. All of the confidence intervals (CIs) were calculated at 95%, and all hypotheses were tested using an alpha level of 5%. STATA 9.2[®] was used (StataCorp LP, College Station, TX, USA) for the data analysis.

Results

Description of studies

Fifteen studies were identified using the predefined search strategy, involving 357 patients (p50 14, range 4–123). The median follow-up was 3 months (range 0.5–10.5). All of the studies were designed with before and after cohorts, with measurements of the predefined variables taken before and after the SAL procedure. Lipectomy was assisted by suction in 10 (66.6%) studies and by ultrasound in three (20%) studies, and it was not described in two (13.3%) studies. The infiltration technique was wet in four (26.7%) studies, super-wet in two (13.3%) studies, tumescent in one (6.7%) study and not described in eight (53.4%) studies. The mean amount of fat extracted ranged from 2063 to 16,300 ml with a mean \pm SD of 6138 ± 4735 ml. Additional information for the included studies is shown on Table 1.^{7–21}

Risk of bias in the included studies

The median follow-up was 3 months, with only four studies reporting follow-ups of 6 months or more. Nevertheless, 12 (80%) studies accurately described the variables measured, and seven (46.7%) reported the full management of the patients regarding interventions potentially relevant to the outcome measures.

Effects of interventions

After adjusting for the time effect and BMI, there was no significant association between the volume of fat aspirated and hCRP, IL-6, adiponectin, resistin, TNF- α , HOMA, total cholesterol, HDL, LDL, triglycerides, free fatty acids and systolic blood pressure (the number of studies and *p*-values for each variable are shown in Table 2).

In the four studies that included the diastolic blood pressure,^{9,12,14,16} a meta-regression analysis showed a significant association between diastolic blood pressure and BMI (coef. 1.32, *p* < 0.001, 95%CI 0.63–2.00). The association was independent of the time effect, study precision and the amount of aspirated fat (meta-model *p*-value < 0.0001). Additionally, fasting glycaemia was associated with BMI (coef. 1.56, *p* = 0.022, 95%CI 0.23–2.90), and it was independent of the time effect, study precision and the amount of fat aspirated (meta-model *p*-value = 0.0005).

The plasma leptin levels were analysed in six studies.^{8,9,12,14,18,19} The meta-regression model showed that the leptin level was significantly decreased relative to the amount of fat aspirated, and it was increased relative to the BMI. The amount of fat aspirated and the BMI were independent of the time effect and the study sample size (Figure 2).

Fasting insulin was analysed in five studies,^{8,13,15,16,21} and the meta-analysis showed a significant association with the amount of fat aspirated. The association was independent of the study precision, the time effect and BMI. The details of regression coefficients, CIs and *p*-values are provided in Table 3.

Table 2 Number of studies and *p*-value or variables non-significantly associated with volume of fat aspirated.

Variable	Number of studies	<i>p</i> -value
hCRP	4	0.4438
IL-6	3	0.9698
Adiponectin	5	0.2486
Resistin	2	0.9698
TNF- α	3	0.4699
HOMA	6	0.1066
Total cholesterol	9	0.8589
HDL cholesterol	7	0.7724
LDL cholesterol	4	0.2659
Triglycerides	7	0.3925
Free fatty acids	2	0.8830
Systolic Blood Pressure	4	0.2394

Discussion

Although liposuction has become a powerful and popular tool for body contouring, there is no evidence to support the hypothesis that subcutaneous fat removal reduces the incidence of CV or metabolic disease or its early markers or RFs.

Data to support the hypothesis that the removal of abdominal wall fat leads to a decrease in the incidence of metabolic or CV disease are scarce. The findings of this systematic review are limited by the design of the studies included. There were no randomised controlled trials that address the long-term effects of SAL on CV disease or its metabolic markers. According to our review, the only hormone that presented decreased levels due to SAL was leptin, a 16-kD cytokine synthesised by adipocytes that acts as a marker of the total fat mass. Adipose tissue is responsible for 80% of the total production of leptin,²² and 80% of the leptin produced by adipose tissue is generated by the subcutaneous tissue. The principal biological function of leptin is to control food intake by means of the

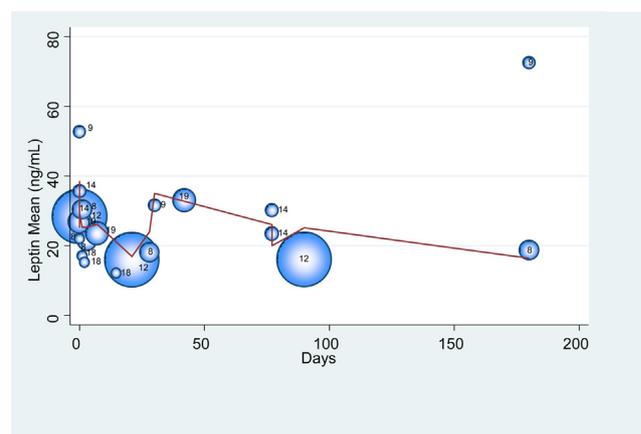


Figure 2 Meta-regression scatter-plot showing the trend line to the decrease of the leptin levels in time. Study weight is symbolized by the dot diameter, each study is identified by its reference number.

Table 3 Number of studies, regression coefficients and *p*-values of variables significantly associated with volume of fat aspirated.

Outcome variable	Control variables	Number of studies	Coefficient	95% Confidence interval	Coefficient <i>p</i> -value	Meta-model <i>p</i> -value
Plasma leptin		6	-0.018	-0.003 to -0.0003	0.020	0.0136
	BMI		2.16	0.188 to 1.148	0.032	
	Time effect		-0.050	-0.117 to 0.017	0.142	
	Study precision		-6.72	-14.06 to 0.619	0.073	
Fasting insulin		5	-0.0041	-0.0078 to -0.0004	0.030	0.1907
	BMI		4.53	-0.11 to 9.17	0.056	
	Time effect		-1.69	-5.77 to 2.39	0.418	
	Study precision		-6219	-35240 to 22803	0.675	

BMI: body mass index.

central nervous system, stimulating anorexigenic peptides and reducing energy expenditure.²³ There is only one study implicating leptins as an independent RF for coronary heart disease,²⁴ and other authors argue that the risk is not attributable to leptin itself, but rather to the persistent inflammatory state associated with obesity. In this model, the elevated leptin levels could be the result of the higher resistance of leptin molecular receptors.^{25–28}

The relationship between subcutaneous fat tissue and CV RFs is controversial. Although we did not find any association between the total amount of fat aspirated and a reduction in markers of CV risk, there is a substantial amount of literature indicating that subcutaneous and visceral fat are directly associated with insulin resistance, particularly in women. It is also believed that the amount of intra-abdominal fat is associated with metabolic syndrome. According to other researchers,^{29,30} subcutaneous fat could be linked to insulin resistance and the superficial fat layer could be linked to leptin levels, whereas the deep layer and abdominal fat may be associated with insulin resistance. However, surgical removal of the omentum does not consistently lead to an improvement of the metabolic syndrome.^{31–34}

Randomised controlled trials are needed to fully address this research question. Trials should be conducted based on a control branch, consisting of a population subjected to dietary modifications, lifestyle adjustments and/or metabolic surgery with monitoring of early markers for metabolic/CV disease, and an active branch with SAL. The outcome measurements should be the incidence of metabolic/CV disease, the variation in the early markers following the intervention or the time to achieve a metabolic 'end' point.

Conclusions

There is no evidence to support the hypothesis that fat removal from the abdominal wall, by either suction or direct excision, decreases CV risk or the inflammatory markers associated with metabolic syndrome.

Disclosure

None.

Funding

None.

Conflicts of interest

None declared.

Ethical approval

Not required.

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