

# Pulmonary Embolism After Combined Abdominoplasty and Flank Liposuction

## *A Correlation With the Amount of Fat Removed*

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**Background:** We prospectively followed patients who underwent esthetic abdominoplasty and flank liposuction to determine the influence of the amount of fat removed on the occurrence of pulmonary embolism.

**Materials and Methods:** We recruited patients undergoing abdominoplasties and flank liposuction and composed 2 groups according to the amount of fat removed, one of small resections (<1500 g) and the other of great resections (>1500 g). All patients received deep vein thrombosis prophylaxis.

**Results:** Since January 2005, we enrolled 103 patients and registered 3 embolisms (2.9%). All occurred in nonsmokers, had no risk factor for deep vein thrombosis, and a resection weight greater than 1500 g (21.4%; 3/14). The calculated relative risk conferred by the amount of fat greater than 1500 g was 7.4. An association was also found with duration of surgery: all embolisms occurred in patients that underwent long operation (>140 minutes; 8.8%; 3/34) with a relative risk of 3.0.

**Conclusions:** The amount of fat removed during plastic surgery is a factor influencing the occurrence of pulmonary embolism in patients undergoing abdominoplasty/flank liposuction, and the duration of surgery is a concomitant factor. Should this data be confirmed, specific measures for prevention of this serious complication could be developed.

**Key Words:** abdominoplasty, liposuction, postoperative complications, pulmonary embolism

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**P**ulmonary embolism (PE) is an important and sometimes catastrophic complication of surgery that causes every year significant morbidities and deaths. Since the appearance

of first specific preventive guidelines,<sup>1</sup> few studies focused on PE occurrence in plastic surgery. In 2001, Reinisch analyzed responses of 273 plastic surgeons performing 9937 face lifts and found that 0.14% of subjects experienced this complication.<sup>2</sup> A recent survey conducted on 334 plastic surgeons outlined that combined operations of abdominoplasty with liposuction had the greatest incidences of deep vein thrombosis/pulmonary embolism (DVT/PE: 12.6% of cases), even when surgeons adopted a correct DVT prophylaxis for their patients (preoperative and postoperative mechanical elastic stockings and low-molecular-weight heparin).<sup>3</sup>

To further investigate this category of patients and possibly find practical elements to help surgeons avoid such complication, we prospectively recruited all patients undergoing combined abdominoplasties-liposuctions of flanks and followed them in the early postoperative period. Our working hypothesis was that the amount of fat removed during surgery could influence the occurrence of PE during resective operations and, for this reason, we searched a correlation between PE and fat removed and tried to identify a cutoff value that could classify patients according to their risk.

### MATERIALS AND METHODS

Patients presented in the hospital, with a random access, to undergo routine preoperative investigations and for a final revision of surgical indications. The enrolment was conducted with a controlled strategy that allowed obtaining 2 different groups (small versus great resections) homogeneous for age, height, weight, and BMI. Inclusion criteria consisted in female patients with age between 40 and 60 years, BMI between 24 and 35 and undergoing abdominoplasties with flanks liposuction for esthetic purposes. These criteria were selected according to a previous internal survey of the Dolan Park Hospital that individuated characteristics of subjects that most frequently underwent this type of surgery. We excluded patients that received abdominoplasty alone or with procedures different from flank liposuction (ie, breast surgery or thigh liposuction), those under contraception or other hormone therapies, those with known coagulation anomalies or altered coagulation proofs, those that underwent body contouring for bariatric weight loss, and those affected by systemic diseases (ie, arteriosclerosis, diabetes mellitus). When all conditions were satisfied, and the inclusion/exclusion

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criteria of the study were met, patients were investigated with specific questions about DVT risk factors. After registration of collected data on the clinical sheet and a careful explanation about purposes and risks of the study, patients were asked to participate and had an informed consent signed. The institutional ethics committee approved the study.

### Preoperative Care

Patients were recovered for 2 nights. All of them received low molecular weight heparin (LMWH) 2 hours before surgery (4000 U/d s.c.) along with elastic stockings/mechanical calf compression until complete mobilization was obtained. Controlled body temperature was achieved with thermic sheet during surgery. Infection prophylaxis consisted in one dose of cefuroxime 750 mg (erythromycin—1 g—if specific allergies were referred), 1 hour before surgery.

### Postoperative Care

Tramadol was usually given as analgesic on patient's request. During the first postoperative day, patients received LMWH 4000 U/d and early mobilization was solicited from 3 to 6 hours from surgery. On the second postoperative day, LMWH was reduced to 2000 U/d and suspended from the 3rd postoperative day, when patients were discharged home. Antibiotic therapy continued until the third postoperative day. Outpatient follow-up visits were planned at the 7th, 14th, and 30th postoperative day and after 6 months.

Primary endpoints of this study were to assess the incidence of clinically evident PE, defined on the basis of signs and radiologic evaluation, and any relationship between PE occurrence and the amount of fat removed. For this purpose, we recorded the amount of flap resected with abdominoplasty and of fat aspirated with liposuction, age, sex, weight, height, smoking status, number of cigarettes smoked/day and years of smoke, BMI, postoperative seromas and wound infections. We calculated the number of pack years (according to the National Cancer Institute Definition of Pack Year) and the amount of total fat removed as the sum of fat resected with abdominoplasty and aspirated with liposuction. Milliliters were transformed into grams assuming an adipose tissue density of 0.95 g/mL, and a corrective factor of 0.3 was derived from the technique of tumescent liposuction (infiltrated/aspirated ratio = 1:1), estimating that the real, "pure" amount of fat removed was 30% of the total fluid aspirated.<sup>4</sup> Finally, according to the total amount of fat removed, patients were classified in 2 groups: small resections (total fat removed <1500 g) and great resections (>1500 g). This cutoff was individuated after the statement of the American Society of Plastic Surgeons, adopting their suggestion of a maximum of 1000 mL of fat removed with liposuction (950 g), when associated with abdominoplasty, and calculating a contribution of additional 500 g for the weight of the abdominal flap resected.

### Statistical Analysis

All data analysis was performed using the Statistical Package for the Social Sciences Windows version 13.0 (SPSS, Chicago, IL). The sample size calculation was based on the reported PE incidence of patients operated with ab-

dominoplasty and flank liposuction and that received a correct DVT/PE prophylaxis (2.6%).<sup>3</sup> Descriptive statistics for quantitative continuous variables were the mean and standard deviation for parametric variables, median and range (minimum and maximum) for nonparametric. Normality assumptions have been demonstrated with histograms, Kolmogorov-Smirnov and Shapiro Wilk testings. Descriptive statistics for qualitative categorical variables was performed with frequencies.

Comparison for groups homogeneity was performed with the Student *t* test for continuous parametric variables, the Mann-Whitney *U* test for continuous nonparametric and the  $\chi^2$  test for categorical variables. The relative risk of the total amount of fat removed on the occurrence of PE was calculated. All *P* values were considered significant if inferior to 0.05.

## RESULTS

We followed CONSORT criteria for the development and description of this trial.<sup>5</sup> The study began in January 2005 and ended in January 2007 with the recruitment of the last patient. We evaluated 143 patients and enrolled 103 of them (72%). None of them was lost to follow-up. Forty patients were excluded: 18 because underwent abdominoplasty alone, 4 apronectomy with liposuction, 2 abdominoplasty with breast augmentation, 1 abdominoplasty with mastopexy, 1 abdominoplasty with liposuction of inner thighs and the remaining 14 because had age and BMI different from inclusion criteria.

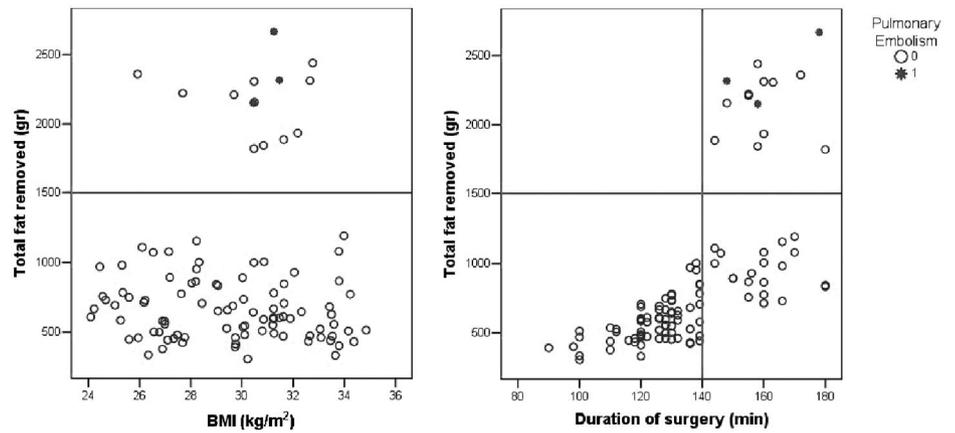
Demographics and clinical characteristics are summarized in Table 1. Thirty-five patients (34%) were smokers, 11 underwent great resection (11/14; 78.6%), and 24 small resections (24/89; 27.0%; Fisher exact test: *P* < 0.001). In smokers, the number of pack years was significant greater in those that underwent great resections versus small resections (Mann-Whitney *U* test; *P* < 0.001). Groups were similar for age and BMI, but differed for the amount of fat removed and for the duration of surgery (*t* test; *P* < 0.001; Fig. 1). The amount of fat resected with abdominoplasty and aspirated with liposuction corresponded to approximately 71% and 29% of the total fat removed during surgery. In great resection, fat resected with abdominoplasty was 74.7% and aspirated with liposuction 25.3%, in small resections 68.5% and 31.5% (Table 1, Fig. 2).

We recorded 4 seromas and 8 wound infections (3 of them were deep). All infections occurred in smokers that underwent great resections ( $\chi^2$  test; *P* < 0.001) and involved the flap wound. The most common isolated organisms were the *Staphylococcus epidermidis* and the *S. aureus*.

We experimented 3 cases of PEs (2.9%). One patient experienced PE during the first postoperative day. The episode manifested with syncope and was treated with the advanced life support care. An urgency CT scan showed bilateral thrombi in 2 major pulmonary veins. Immediate treatment began with LMWH, 20,000 UI/d for 5 days. The other patients experienced symptoms of chest pain and breathing impairment after 2 weeks from the operation. They were referred to hospitals with specialized departments for

**TABLE 1.** Patients Demographics and Clinical Characteristics

	Age (years)	Height (cm)	Weight (kg)	BMI	Pack Years	Duration (min)	Total Fat Removed (g)	Flap Resection (g)	Fat Aspirated (g)
All patients (N = 103)									
Mean	52	163	79	30	2.6	136	866	612	254
SD	3.6	6	8	3	6.2	20	569	458	127
Median	52	163	79	30	0	132	667	430	228
Minimum	40	147	60	24	0	90	305	132	74
Maximum	60	180	93	35	43.7	180	2665	2010	655
Small resections (N = 89, 86.4%)									
Mean	52	163	78	30	1.0	133	658	451	207
SD	3.2	5	8	3	1.7	19	213	205	43
Median	52	163	78	30	0	130	608	385	199
Minimum	41	147	60	24	0	90	305	132	74
Maximum	60	170	93	35	7.5	180	1193	937	285
Great resections (N = 14, 13.6%)									
Mean	51	163	82	31	13.0	160	2187	1634	553
SD	3.8	8	7	2	12.2	11	244	245	54
Median	51	163	83	31	10.0	158	2215	1689	556
Minimum	40	147	68	26	0	144	1821	1260	456
Maximum	59	180	93	33	43.7	180	2665	2010	655



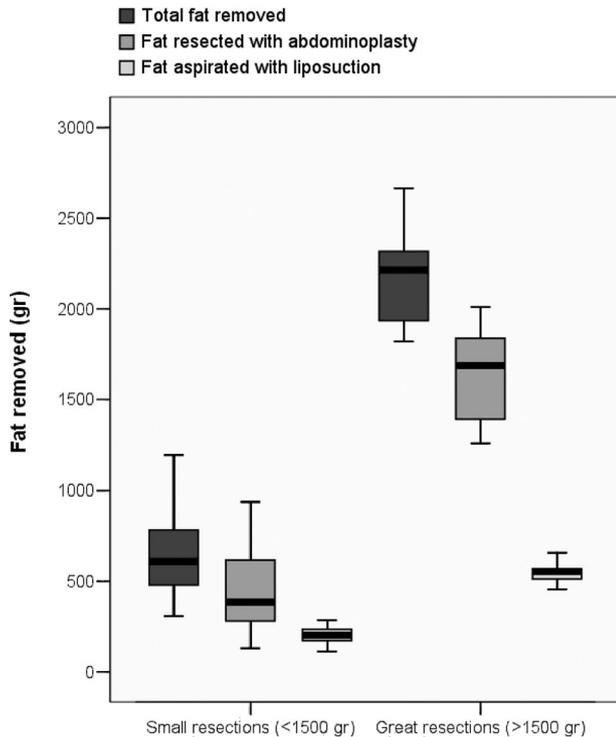
**FIGURE 1.** Scatter plot showing the amount of total fat removed with the flap resection versus BMI (left panel) and versus the duration of surgery (right panel) for the occurrence of PE.

prevention, PE was diagnosed with a CT scan and treatment began with LMWH 18,000/UI/d for 5 days. After discharge, all 3 patients continued LMWH home with 5000/UI/d for the following 5 days, at the end of which another CT scan confirmed thrombi resolution.

Patients affected were nonsmokers and did not assume hormonal replacement therapy or oral contraceptives, had no familiarity for DVT/PE nor previous episodes of DVT. All embolisms occurred after great resections (3/14: 21.4%) that lasted more than 140 minutes (3/34: 8.8%). The occurrence of PE was significantly different in patients undergoing small versus great resections, and long versus short operations (Fisher exact test:  $P < 0.05$ ). Both cutoff values (1500 g and 140 minutes) produced no false negatives while the total fat removed gave 11 false positives (11%) and the duration of surgery 31 false positives (31%). The estimated relative risk for the 1500 g cutoff on PE occurrence was 7.4 (3/14)/(3/103), and for 140 minutes was 3.0 (3/34)/(3/103).

**DISCUSSION**

The plastic surgeon is unfortunately forced to walk a thin line when dealing with DVT/PE prevention, with thromboembolism on one side and postoperative bleeding complications on the other. Although guidelines already exist in other surgeries,<sup>6</sup> plastic surgery patients were not included in studies leading to international recommendations and specific rules were inferentially based on conclusions drawn from the current literature.<sup>1</sup> This brought to some misunderstanding in the clinical practice, for example about the correct classification of patients into “high risk” or “moderate risk,” categories necessary for the adoption of correct preventive measures.<sup>7</sup> Furthermore, still few publications report PE incidences in this specific surgery. Reinisch et al experienced an incidence of 0.14% on a survey of 273 surgeons performing 9937 face lifts.<sup>2</sup> On abdominoplasties, Matarasso showed incidences of 0.02% to 1.1% in his survey,<sup>8</sup> while combined procedures



**FIGURE 2.** Box plot showing the fat removed in patients with great versus small resections. The ends of the boxes are quartiles (25 and 75), the horizontal line is the median value and the vertical line represents the range.

showed disaccording data: when intra-abdominal surgery (hysterectomy) was associated with abdominoplasty, the incidence raised to 6.6%—possibly due to the interference of superficial venous drainage from the pelvis and legs<sup>9</sup>—but, on the contrary, when associated with different types of breast surgery (mastopexy, breast augmentation, or reduction), no major complications were present and minor complications had similar rates to abdominoplasty alone.<sup>10</sup> Finally, considering abdominoplasty with liposuction, a recent survey conducted on 334 plastic surgeons found that these combined operations had the greatest incidences of DVT/PE (13% of cases).<sup>3</sup> Another interesting information from this study is that such incidence was present even with a correct DVT prophylaxis, suggesting that other predictive factors need to be individuated to identify high risk patients.<sup>3</sup>

A recent emerging concept is that the amount of fat removed during surgery is an important risk factor for the occurrence of DVT/PE. This idea was supported by the American Society of Plastic Surgeons, that stated that large volume liposuctions have an increased risk for serious complications when combined with abdominoplasty.<sup>11,12</sup> Furthermore the State of Florida determined with a state law a maximum of 1000 mL of aspirant when liposuction was combined with abdominoplasty.<sup>13</sup> Finally, sporadic reports correlated the overall complications rates with the amount of fat removed.<sup>14,15</sup> In 2 series, for example, patients that removed small amount of tissue (median 700–1000 g) were those that did not experience such complications.<sup>14</sup>

In our study we found 3 PE cases over 103 patients (2.9%), a lower incidence to that reported by Broughton for abdominoplasties with liposuction, when corrected for PE = 70% DVT ( $5\% = 12.6\% \times 70/170$ ),<sup>3</sup> but higher than incidences reported by Matarasso et al on abdominoplasties alone.<sup>8</sup> Both these data indicate relevant incidences of PE in patients that undergo combined abdominoplasties-liposuctions, even when a correct DVT prophylaxis is applied. All our PE patients were nonsmokers, excluding a direct influence of smoking on PE occurrences. Furthermore, 14 patients over 103 (13.6%) removed more than 1500 g of fat and 3 of them (21.4%) experimented PE. No significant difference existed for patients undergoing great versus small resections according to BMI and no correlation was found between the BMI and the amount of fat removed. This suggests the important role of the amount of tissue resected on PE occurrence, confirmed by the high estimated relative risk of great resections versus all patients (RR = 7.4), and the greater contribution to the risk conferred by the fat resected with abdominoplasty (Fig. 2).

The duration of surgery was also an important factor for the occurrence of PE and in our series patients with operation longer than 140 minutes had a risk of 3.0. However, we believe that the main contribution was still conferred by the amount of fat removed. In fact, PE occurred in only 8.8% of patients with surgery longer than 140 minutes (3/34) and, in this subgroup, only in those that underwent great resections (Fig. 1).

## CONCLUSIONS

The incidence of PE in patients undergoing abdominoplasty with flank liposuction is 2.9% in our series, even when a correct prophylaxis is adopted. Resections with more than 1500 g of fat removed had a risk of 7.4, while the duration of surgery (>140 minutes) a risk of 3.0. Results of this study would suggest that patients prone to develop PE could be identified preoperatively by an estimation of the amount of fat to be removed and from the duration of surgery. Future studies are required to confirm this data and develop specific measures for prevention of this serious complication.

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