Wound Infections in Aesthetic Abdominoplasties: The Role of Smoking

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Background: In this prospective study, the authors followed patients who underwent aesthetic abdominoplasty to determine the influence of smoking on the occurrence of postoperative wound infections.
Methods: Patients who underwent aesthetic abdominoplasty were considered eligible for the study. The authors excluded postbariatric patients, those with ongoing clinical infections, those receiving a recent antibiotic course, and those with systemic diseases such as arteriosclerosis and diabetes mellitus. Smokers were advised to quit smoking at least 4 weeks before surgery.
Results: Starting in February of 2004, the authors enrolled 84 patients. Postoperative infections were present in 13 patients (15.5 percent) and were superficial in 10 (77 percent). All but one occurred in smokers. These had a certain number of cigarettes smoked per day, years of smoking, and higher estimated overall number of smoked cigarettes when postoperative infections were present. The relative risk of smoking on infections was 12. A cutoff value of approximately 33,000 overall cigarettes smoked determined 3.3 percent false-positive and 0 percent false-negative rates.
Conclusions: Smoking is an important issue in aesthetic surgery that needs to be accurately addressed during the preoperative interview. In the future, the analysis of smoke-related, easy-to-gather variables such as the estimated overall number of cigarettes smoked until surgery could help stratify patients according to their risk of manifesting infections. (*Plast. Reconstr. Surg.* 121: 305e, 2008.)

The effects of smoking on wound healing were initially studied by Mosely and Finseth in 1977.[1] These authors established that recovery from an injury is compromised in atherosclerotic smoking patients and exposes them to wound problems.[2] Other studies have shown that smoking results in an increased incidence of flap necrosis after face lift and abdominoplasty,[3,4] worse aesthetic wounds,[5,6] and wound dehiscence in reduction mammaplasties and abdominoplasties.[7,8] So far, there has been no investigation of the role of smoking on the incidence of postoperative wound infections in plastic surgery procedures.

Abdominoplasty is a popular procedure in plastic surgery and is used to remove the abdominal excess of fat. This procedure is not free from complications and, among them, wound infections are present in 2 to 7 percent of cases, endangering aesthetic results.[9,10] To define the role of smoking on the occurrence of postoperative infections, we followed patients who underwent aesthetic abdominoplasty and correlated wound problems with the smoking status, the number of cigarettes smoked, and the number of years of smoking.

PATIENTS AND METHODS

We prospectively recruited all patients who underwent abdominoplasty for cosmetic purposes. We excluded (1) patients within 1 year after bariatric surgery, (2) those with ongoing clinical infections or (3) that received a complete antibiotic course in the previous 6 months, (4) those under steroid therapy, and (5) those with systemic diseases that could impair tissue oxygenation or wound repair (e.g., arteriosclerosis, diabetes mellitus). Smokers were investigated with regard to the number of

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cigarettes smoked per day and the overall number of years of smoking, and were invited to stop smoking at least 4 weeks before surgery. Those that failed had their surgery postponed until 4 weeks of cessation were obtained. Every operation was performed at the Dolan Park Hospital (Birmingham, United Kingdom).

Preoperative Care

Patients were allowed to recover for two nights. According to standard prophylaxis measures, if no previous deep venous thrombosis or any specific risk factor was referred, low-molecular-weight heparin was administered (4000 U/day subcutaneously) along with elastic stockings/mechanical calf compression during the day of surgery and on the first postoperative day. If patients were older than 60 years, with a history of deep venous thrombosis or with risk factors, they received heparin 4000 U/day for at least 2 postoperative days and until complete mobilization was obtained. Infection prophylaxis consisted of one dose of cefuroxime 750 mg (erythromycin, 1 g, if specific allergies were referred).

Postoperative Care

Tramadol was usually given as an analgesic at the patient's request. Early mobilization was encouraged from 3 to 6 hours after surgery. Patients without complications were discharged 48 hours later. Outpatient follow-up visits were planned at postoperative days 7, 14, and 30 and after 6 months. Postoperative infections were defined on the basis of clinical signs (e.g., cellulitis, pain, swelling, drainage, elevation of white blood cells, fever), exudate cultures, superficial infections such as those involving the skin and subcutaneous tissues, and deep infections including muscle and fascia. Superficial infections were managed with an antiseptic solution, cleaning, and antibiotic creams. When indicated (signs of sepsis, such as fever or increase in white blood cell count), an oral antibiotic course was started. In cases of deep infections, wound dehiscences, or pus discharge, the patient was readmitted for intravenous antibiotics and surgical wound debridement (Fig. 1).

The aim of this study was to assess whether smoking status influenced the incidence of postoperative infections in aesthetic abdominoplasties. We recorded the sex and age of the patients, height and weight, type of operation, amount of fat removed, smoking status, number of cigarettes smoked per day, overall number of years of smoking, overall number of infections, and number of superficial and deep infections. We also calculated the estimated overall number of cigarettes smoked (cigarettes per day × years of smoking × 365).

Fig. 1. Deep infection after abdominoplasty in a 54-year-old woman who smoked 30 cigarettes per day for 20 years. The patient was treated with intravenous antibiotics, serial medications (povidone-iodine gauzes), and surgical debridements.

Statistical Analysis

All data analysis and calculations of sample size were performed using SPSS for Windows Version 13.0 (SPSS, Inc., Chicago, Ill.). Descriptive statistics for quantitative continuous variables are reported as mean ± SD (parametric) or median and range (nonparametric); categorical variables are presented with frequencies.

Comparison for group homogeneity was performed with the *t* test for continuous variables and with the chi-square test for categorical variables. In smokers, comparison of infections with infection-free patients regarding the number of cigarettes smoked per day, the number of years of smoking, and the estimated overall number of cigarettes smoked until surgery was performed using the chi-square test. Correlation analysis between these variables and the occurrence of infections was conducted with the nonparametric Spearman's correlation test. Values of $p < 0.05$ were considered significant. The relative risk of smoking on the occurrence of overall infections and a cutoff value for the estimated number of cigarettes between patients who developed infections and those who were infection-free were also calculated.

RESULTS

We recruited 84 patients from February of 2004 to February of 2006. No patient was lost to follow-up. Descriptive statistics and frequencies

are summarized in Table 1. All tests used for normality confirmation proved a normal distribution for continuous variables except the estimated overall number of cigarettes smoked until surgery. Infections occurred after a mean ± SD of 11 ± 3.8 days: 7 ± 2.8 days for superficial infections and 18 ± 3.8 days for deep infections. The most common organisms isolated were *Staphylococcus epidermidis* and *Staphylococcus aureus*. Three smokers developed deep infections. One of them required four surgical debridements and serial medications over an 8-week period (Fig. 1). We recorded three seromas (3.6 percent), one in smokers and two in nonsmokers. No postoperative bleeding, deep vein thrombosis, or pulmonary embolism was observed.

Statistical Analysis

The *t* test and the chi-square test confirmed that both groups (smokers and nonsmokers) were homogeneous. All infections but one occurred in smokers, resulting in a significant difference according to smoking status ($p < 0.001$) (Table 1).

Analysis of the occurrence of infections in smokers showed significant differences between patients who developed infections versus those infection-free for the number of cigarettes smoked per day ($p < 0.001$, chi-square test), years of smoking ($p < 0.001$, chi-square test), and overall estimated number of cigarettes smoked ($p = 0.001$, chi-square test). All values were higher in patients who developed infections than in those who were infections-free (Table 2 and Fig. 2). Among patients who developed infections, those with deep infections ($n = 3$) had the highest values for the three parameters.

Infections were highly correlated with the number of cigarettes per day ($\rho = 0.777$; $p < 0.001$), the years of smoking ($\rho = 0.716$; $p < 0.001$), and estimated overall number of cigarettes ($\rho = 0.806$; $p < 0.001$). Relative risk of infections attributable to smoking was 12. The comparison between infections versus infections-free patients produced a prognostic cutoff value, based on the 95 percent confidence intervals, for the overall estimated number of cigarettes of approximately 33,000 cigarettes (32,569); there was one false-positive (3.3 percent) and no false-negatives (Fig. 3).

DISCUSSION

Smoking increases the risk of complications in plastic surgery, resulting in poor aesthetic outcomes,[3–10] and different processes seem involved. Principal components of tobacco (i.e., nicotine, nitric oxide, and carbon monoxide) influence wound healing in peripheral tissues[2,11–13]; blood flow of the flap's distal portion has the highest sympathetic innervation and is particularly sensitive to the vasoconstrictive effects of smoking[14,15]; and an increased level of carboxyhemoglobin and platelet adhesiveness with microthrombi formation lead to a reduced ability to deliver oxygen.[16,17] Finally, the increased serum levels of fibrinogen and hemoglobin along with decreased fibrinolytic activity and a direct endothelial injury in smokers[18,19] contribute to reduced local circulation. Reports of major flap necrosis after abdominoplasty support this idea.[20]

Abdominoplasty—as does face lifting and mastectomy—requires undermining of a large flap. In 2003, Manassa and colleagues reported a 47.9 percent rate of wound-healing problems in smokers (14.8 percent in nonsmokers),[8] and smoking increased the chance of developing wound problems 3.2-fold. Analysis of our patients showed that postoperative infections were present in 15.5 percent ($n = 13$) of cases and that 77 percent ($n = 10$) were superficial. These results, even if similar

Table 1. Descriptive Statistics*

Variable	All Patients (%)	Smokers (%)	Nonsmokers (%)	*p*
No. of subjects	84	42 (50)	42 (50)	—
Age, year	42 ± 23	41 ± 20	45 ± 25	NS†
Male/female	33/51	16/26	17/25	NS‡
Weight, kg	72 ± 8.5	69 ± 5.3	74 ± 4.8	NS†
Height, cm	167 ± 13	165 ± 9	171 ± 8	NS†
BMI	26 ± 3	25 ± 2	25 ± 2	NS†
Flap removed, kg	0.7 ± 0.9	0.7 ± 0.6	0.8 ± 0.7	NS†
Fat aspirated with liposuction, ml	920 ± 484	860 ± 456	940 ± 468	NS†
Seromas	3 (3.6)	1 (1.1)	2 (2.4)	NS‡
Infections	13 (15.5)	12 (14.3)	1 (1.2)	<0.001‡

M, male; F, female; NS, not significant; BMI, body mass index.
*The analysis between smokers and nonsmokers was conducted with the *t* test for continuous variables (†) and the chi-square test for categorical variables (‡). Values were expressed as mean ± SD and frequencies, except for the estimated overall number of cigarettes smoked, where median and range were used.

Table 2. Data Regarding Number of Cigarettes per Day, Number of Smoking Years, and Estimated Overall Number of Cigarettes until Surgery for Smoking Patients*

Variable	Smokers (*n* = 42)			Smokers without Infections (*n* = 30)			Smokers with Infections (*n* = 12)		
	Cigarettes/Day	Years of Smoking	Overall No. of Cigarettes	Cigarettes/Day	Years of Smoking	Overall No. of Cigarettes	Cigarettes/Day	Years of Smoking	Overall No. of Cigarettes
Mean	7.4	13.7	41,454	4.5	11.9	19,571	13.9	17.7	90,267
SD	5.8	3.7	41,138	1.2	2.5	6632	6.9	2.6	44,057
Median	5	15	27,375	5	10	18,250	15	20	98,550
Minimum	3	10	10,950	3	10	10,950	5	15	32,850
Maximum	30	20	164,250	8	15	32,850	30	20	164,250

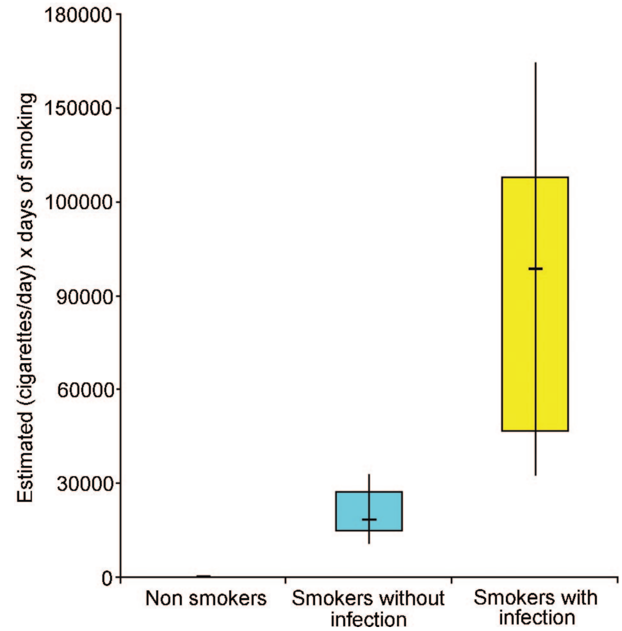

Fig. 2. Box plot graphs comparing nonsmokers and smokers that developed infections (*yellow box*) versus those that did not (*blue box*) for the overall estimated number of cigarettes smoked.

to others,[20–22] are still lower than those expressed by Manassa et al.[8] In fact, we recruited as "smokers" people that had quit 4 weeks before surgery and excluded those actively smoking: both issues could explain the lower complication rate of our patients. However, given the occurrence of 12 infections in smokers even with a smoking-free window of 4 weeks, this period of time could not be enough to completely prevent postoperative infections. Future studies need to compare patients with different smoking-free windows and analyze the incidence of postoperative infections.

We divided our series of patients into two groups according to their smoking habit. Almost all infections occurred in smokers, with a 12-fold increased risk of developing wound infections, confirming a direct and important influence of smoking. Definitive conclusions cannot be drawn from the low number of deep infections; however, patients who experienced them had, among smokers, the highest values for number of cigarettes smoked per day, years of smoking, and estimated overall number of cigarettes smoked. It is possible that the lower rate of deep infections compared with superficial is explained by the need of the former for other cofactors not present in the latter. Although our patients were highly selected and homogeneous according to the inclusion and exclusion criteria and no particular differences

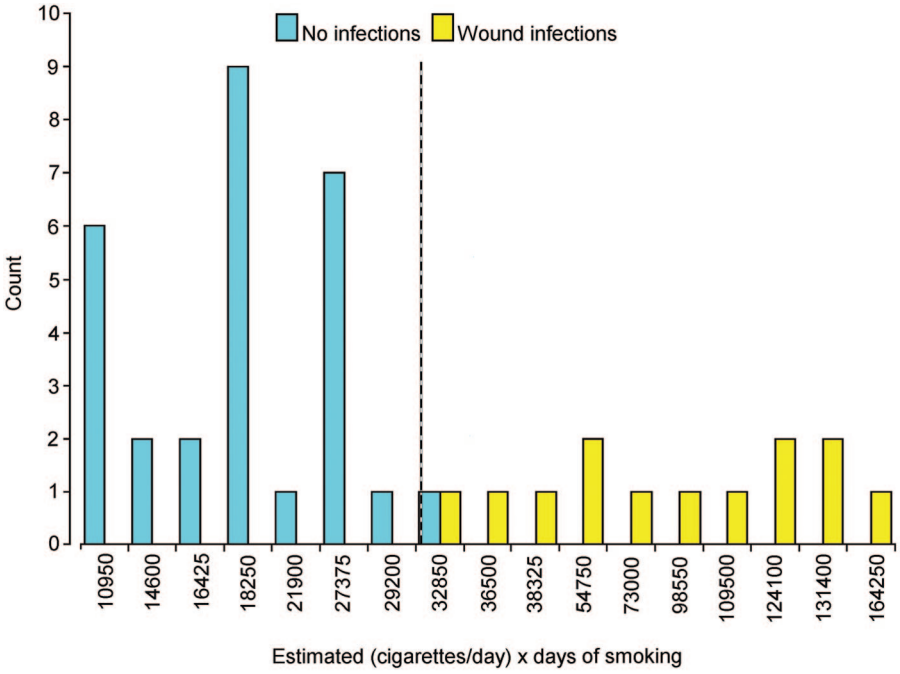

Fig. 3. Bar graph showing smokers who developed infections (*yellow bars*), those who were infections-free (*blue*), and the cutoff line (32,569 cigarettes).

predisposing to deep infections were present (i.e., diabetes), this issue is worthy of being addressed by future studies to identify preoperatively patients at greater risk and to adopt particular measures at follow-up.

Our analysis confirmed that the greater the number of cigarettes consumed per day, years of smoking, and estimated overall number of cigarettes, the greater the association with infections. A cutoff value of approximately 33,000 cigarettes identified 3.3 percent of false-negatives and 96.7 percent of true-positives (Fig. 3). This means that, should these data be confirmed, most smoking patients prone to develop postoperative wound infections could be identified preoperatively and followed differently in the early postoperative period. Although the estimated overall number of cigarettes is only a theoretical parameter, this estimation is easily gathered and furnishes the intriguing possibility of predicting postoperative outcomes with a few simple questions during history-taking. These data, if confirmed, could be used to stratify smokers according to their estimated risk of developing postoperative infections and provide them with specific care.

CONCLUSIONS

The incidence of infections was 15.5 percent, and almost all occurred in smoking people. The relative risk conferred by smoking was 12, and a cutoff value of 33,000 overall estimated cigarettes identified 0 percent of false-positives and 3.3 percent of false-negatives. If future, larger studies confirm these data, surgeons could have a simple and easy method with which to predict the risk of their smoking patients to develop postoperative infections.

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