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ORIGINAL ARTICLE

Postoperative Wound Infections After Breast Reductions: The Role of Smoking and the Amount of Tissue Removed

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Abstract

Background This prospective study followed patients who underwent breast reductions to determine the influence of smoking and the amount of tissue removed on postoperative wound infections.

Methods Patients who had received breast reductions were considered eligible for the study. The study excluded postbariatric patients and those with ongoing clinical infections, a recent antibiotic course, or systemic diseases that could impair tissue oxygenation. Smokers were instructed to quit smoking at least 4 weeks before surgery.

Results By March 2004, the study had enrolled 87 patients. Postoperative infections were present in 24 cases (27.9%). Infections included 16 in smokers (37.2%), 8 in nonsmokers (18.2%; $p < 0.05$), 14 in patients with large resections (>0.85 kg; 70%), and 10 in patients with small resections (14.9%; $p < 0.001$). Significant differences were found between the patients who experienced infections and those who were infection free in terms of the overall estimated cigarettes smoked (mean, 146,000; range, 29,200–228,125 vs mean, 10,950; range, 9,125–54,750; $p < 0.001$), the number of pack years (mean, 20; range, 4–31 vs mean, 2; range, 1–8; $p < 0.001$), and the amount of tissue removed (mean, 0.9 kg; range, 0.5–2 kg vs mean, 0.5 kg; range, 0.2–1.4 kg; $p < 0.001$). The analysis for all the patients determined an odds ratio of 2.04 for smoking and 4.7 for the amount of tissue removed.

Conclusions Smoking and the amount of tissue removed are important issues in aesthetic breast surgery that need to be addressed accurately by the plastic surgeon. If future larger studies confirm these data, surgeons could have a simple and easy method for stratifying patients according to their risk for the development of wound infections and for prescribing specific preventive measures.

Keywords Aesthetic surgery · Breast reductions · Postoperative complications · Smoking

Breast reduction, a most popular procedure, is performed to improve functional disorders (back pain) and aesthetic problems (reduction in size, creation of good central projections, and replacement of the nipple–areola complex in a correct position) for patients affected by gigantomastias. The operation has become even more popular with the recently increased number of bariatric surgery operations, which have resulted in the necessity to remove functional and aesthetic deformities after massive weight losses.

Breast reductions have an overall wound complication rate of 15% to 50% [1–4], and numerous studies have found a consistent association with different risk factors including shoulder strap groovings, vertical incisions, obesity, older age, smoking history, resection weight, and history of diabetes mellitus [4–11]. When present, these factors delay the healing process, increase morbidity, and endanger the aesthetic result. Wound infections have an incidence of 1% to 20% [3, 4, 12–14] and are related to the amount of tissue removed (1,000 g) and the body mass index (BMI) [6].

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Journal : Large 266 | Dispatch : 11-10-2007 | Pages : 7
Article No. : 9048 | ☐ LE | ☐ TYPESET
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To date, no study has specifically investigated the relationship between the patient's smoking status and the incidence of postoperative wound infections. For that reason, we conducted this prospective study to address this issue. We have also analyzed the amount of tissue resected in an effort to find the specific contribution of each factor (smoke and tissue resected) to the occurrence of infections.

Materials and Methods

We prospectively recruited all patients who had undergone breast reductions and excluded those who had previously undergone bariatric surgery, those who had ongoing clinical infections or had received a complete antibiotic course in the 6 months preceding the operation, those receiving steroid therapy, and those with systemic diseases that could impair tissue oxygenation or wound repair (arteriosclerosis, diabetes mellitus) (Tables 1 and 2). Smokers were questioned about the number of cigarettes smoked per day and the overall years of smoking, and were instructed to stop smoking at least 4 weeks before surgery, according to the hospital's policy. Written confirmation of the abstinence was received by patients and by their relatives. Those who failed to stop smoking had their surgery postponed until they had obtained 4 weeks of smoking cessation.

Every operation was performed at the Dolan Park Hospital (Bromsgrove-Birmingham, UK) by the same team consisting of two surgeons (A.A. and A.F.) using T-inverted incisions and the inferior areolar pedicle technique.

Preoperative Care

The patients recovered for 2 days. Prophylaxis for deep venous thrombosis consisted of low-molecular-weight heparin 4,000 U/day administered subcutaneously 30 min before surgery, elastic stockings, and mechanical calf compression. If specific allergies were referred, one dose of intravenous (IV) cefuroxime (750 mg) and IV erythromycin (1 g) was administered 10 to 30 min before the operation for infection prophylaxis.

Postoperative Care

Three additional doses of IV antibiotic were administered every 12 h during the first 2 postoperative days. Early mobilization was solicited 4 to 8 h after the operation, and deep venous thrombosis prophylaxis was continued with one dose of low-molecular-weight heparin 4,000 U/day administered subcutaneously the following morning. Tramadol usually was given as an analgesic at the patient's request. Drains were kept in place for at least 48 h and removed only when the total amount of fluid aspirated was less then 200 ml/day for each breast. Patients without complications were discharged 48 h after surgery.

Outpatient follow-up visits (physical examination) were planned for postoperative days 7, 14, and 30, then at 6 months. Postoperative infections were defined on the basis of clinical signs (cellulitis, pain, swelling, drainage, wound dehiscence, elevation of white blood cells, fever) and exudate cultures (in cases of wounds dehiscence or drainage). Superficial infections were defined as those involving the skin and subcutaneous tissues, and deep infections were those deeper or in the presence of breast abscesses.

Superficial infections were managed with an antiseptic solution cleaning and local antibiotic creams applied three times per day. Whenever indicated by cellulites, pain, fever, or white blood count rise, an oral antibiotic course was started. In cases of deep infection, wound dehiscence, or pus discharge, the patient was readmitted to the hospital, where an intravenous antibiotic course was started and a surgical debridement was performed. The wound was closed with fascial, subcutaneous, and dermal sutures, with a 12-mm surgical drain left in place for 12 h. Finally, patients were discharged with a prescription for 4 days or an oral antibiotic course.

This study aimed to assess whether smoking and the amount of tissue removed influenced the occurrence of infections in breast reductions. We recorded the sex and age of patients, as well as their height, weight, BMI, amount of breast tissue removed, smoking status, number of cigarettes smoked per day, years of smoking, overall infections, superficial and deep infections, and other

Table 1 Descriptive statistics of anthropometric measures (complete sample)

	All patients (n = 87)				Nonsmokers (n = 44)				Smokers (n = 43)			
	Age	Weight (kg)	Height (cm)	BMI	Age	Weight (kg)	Height (cm)	BMI	Age	Weight (kg)	Height (cm)	BMI
Mean	54	76	163	28.7	54	77	163	29.2	54	75	163	28.2
SD	5	10	6	4	6	10	6	4	4	10	6	4
Median	53	73	163	28.4	52	75	163	29.2	54	73	163	28.2
Minimum	41	59	147	20.4	41	59	147	21.4	47	59	147	20.4
Maximum	70	93	180	39.8	70	92	177	39.8	61	93	180	36.4

BMI, body mass index; SD, standard deviation

Journal : Large 266 Dispatch : 11-10-2007 Pages : 7
Article No. : 9048 LE TYPESET
MS Code : 9048 CP DISK

Table 2 Data on the estimated overall number of cigarettes smoked until surgery and the number of pack years for smoking patients

	Nonsmokers (n = 44)	Smokers (n = 43)			Smokers without infections (n = 27)			Smokers with infections (n = 16)		
	Tissue removed	Tissue removed	Total cigarettes	Pack years	Tissue removed	Total cigarettes	Pack years	Tissue removed	Total cigarettes	Pack years
Mean	0.6	0.8	56,787	8.0	0.5	17,168	2.7	1.2	123,644	17.0
SD	0.2	0.5	63,426	8.5	0.2	13,696	1.9	0.5	57,844	7.8
Median	0.6	0.5	18,250	3.0	0.4	10,950	2.0	1.2	146,000	20.0
Minimum	0.4	0.2	9,125	1.0	0.2	9,125	1.0	0.6	29,200	4.0
Maximum	1.0	2.0	228,125	31.0	1.4	54,750	8.0	2.0	228,125	31.0

SD, standard deviation

complications including seromas, hematomas, pulmonary embolism. We also calculated the estimated cigarettes smoked overall (cigarettes/day × years of smoking × 365) and the number of pack years, according to the National Cancer Institute definition of a pack year.

Statistical Analysis

All data analysis and calculation of sample size were performed using the Statistical Package for the Social Sciences Windows, version 13.0 (SPSS, Chicago, IL, USA). Descriptive statistics for quantitative continuous variables were the mean ± standard deviation for parametric variables and the median and range (minimum and maximum) for nonparametric variables. Normality assumptions were demonstrated with histograms as well as Kolmogorov/Smirnov and Shapiro Wilk testing. Descriptive statistics for qualitative categorical variables were presented with frequencies.

Homogeneity between groups was verified in continuous variables, with the z test used for comparison of means, the Levene's test for comparison of variances, and the chi-square test for categorical variables. The Mann–Whitney test was used to compare smokers who experienced infections with those who did not regard the estimated overall cigarettes used or the number of pack/year smoked until the operation. The odds ratios (ORs) for infections by smoking and by amount of tissue removed also were calculated. A cutoff value for the amount of tissue removed was determined with ROC curves (sensitivity and specificity). All p values less than 0.05 were considered significant.

Results

We recruited 87 patients from March 2004 to August 2006. None was lost to follow-up evaluation. These patients had an overall age was 54 ± 5 years, a weight 76 ± 10 kg., a height of 163 ± 6 cm, and a BMI of 28.7 ± 4 (Table 1). A total of 55 patients (63%) were employed, and 62 (71%) had more than a high school education.

All tests used for normality confirmation proved a normal distribution for continuous variables except the estimated overall cigarettes smoked until surgery, the number of pack years, and the amount of tissue removed during surgery. Smokers represented 49.4% of the patients (n = 43). Infections (confirmed with positive cultures) were present in 27.6% of the patients (n = 24): 19 superficial and 5 deep. They occurred after a mean of 8 ± 2.9 days: superficial infections after 6 ± 1.9 days ± and deep infections after 13 ± 2.4 days. The most common organisms isolated were *Staphylococcus epidermidis* and *S. aureus*. We recorded one seroma (1.1%) and two hematomas (2.3%). No deep vein thromboses or pulmonary embolisms were observed.

Statistical Analysis

The z test confirmed that the groups (smokers vs nonsmokers and more than 0.85 kg vs less than 0.85 kg tissue removed) were homogeneous for the variables analyzed: age, height, weight, and BMI. The smokers had 16 infections (37.2%), and the nonsmokers had 8 infections (18.2%; $p < 0.05$, chi-square test). Superficial infections occurred in 19 patients (21.8%): 12 in smokers (27.9%) and 7 in nonsmokers (15.9%; $p > 0.05$, chi-square test). Deep infections occurred in 5 patients (5.7%): 4 in smokers (9.3%) and 1 in nonsmokers (2.3%; $p > 0.05$, chi-square).

The analysis of infection occurrence in smokers showed significant differences between the patients who experienced infections and those who were infection free in the overall estimated cigarettes smoked (mean, 146,000; range, 29,200–228,125 vs mean, 10,950; range, 9,125–54,750; $p < 0.001$, Mann–Whitney test) and the number of pack years (mean, 20; range, 4–31 vs mean, 2; range, 1–8; $p < 0.001$, Mann–Whitney test) (Fig. 1). Among the patients who experienced infections, those with deep infections (n = 5) had the highest values.

Journal : Large 266 | Dispatch : 11-10-2007 | Pages : 7
Article No. : 9048 | LE | TYPESET
MS Code : 9048 | CP | DISK

There were 14 infected patients (70%) among those with large resections (>0.85 kg) and 10 infected patients (14.9%) among those with small resections (<0.85 kg; $p < 0.001$, chi-square). Superficial infections occurred in 10 large resections (50%) and in 9 small resections (13.4%); $p = 0.001$, Fisher's exact test). Deep infections occurred in 4 large resections (20%) and in 1 small resection (1.5%; $p = 0.009$, Fisher's exact test). The analysis of infection occurrence showed significant differences in the amount of tissue removed (mean, 0.9 kg; range, 0.5–2.0 kg vs mean, 0.5 kg; range, 0.2–1.4 kg; $p < 0.001$, Mann-Whitney test) between the patients who experienced infections and those who were infection free (Fig. 1).

To determine the greatest areas of sensitivity and specificity, cutoff values were calculated with ROC curves. Overall, a cutoff of 0.85 kg for the amount of tissue removed corresponded to an area of 0.897 (sensitivity, 0.58; specificity, 0.90): 0.694 (sensitivity, 0.50; specificity, 0.89) for nonsmokers and 0.820 (sensitivity, 0.63; specificity, 0.93) for smokers. Among smokers, a cutoff of 6.85 pack years produced an area of 0.980 (sensitivity, 0.88; specificity, 0.93).

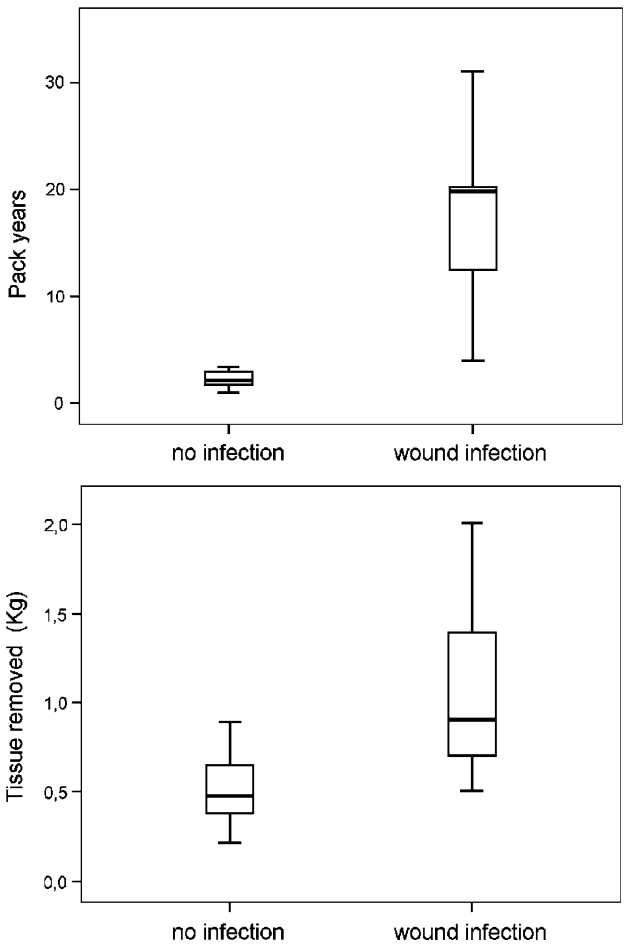

Fig. 1 Box plot graphs comparing patients for the amount of breast tissue removed (*lower panel*) and smokers for the number of pack years (*upper panel*) classified by infection status

For all the patients, the analysis of smoke (smokers vs nonsmokers) and the amount of tissue removed (cutoff value of 0.85 kg) determined four different subgroups for the incidence of postoperative infections and ORs (Fig. 2). The smokers had an incidence of 37.2% (16/43), and the nonsmokers had an incidence of 18.2% (8/44) (OR, 2.04). The patients with large resections (>0.85 kg) had an incidence of 70% (14/20), and those with small resections had an incidence of 14.9% (10/67) (OR, 4.7). The smokers with large resections had an incidence of 83.3% (10/12), and smokers with small resections had an incidence of 19.3% (6/31) (OR, 4.3). The incidence among nonsmokers with large resections was 50% (4/8), and that among nonsmokers with small resections was 11.1% (4/36) (OR, 4.5). The ORs between smokers and nonsmokers for large and small resections was 1.7.

For smokers, the analysis of smoking (cutoff value of 6.85 pack years) and the amount of tissue removed (cutoff value of 0.85 kg) determined four different subgroups for the incidence of postoperative infections and ORs (Fig. 2). The incidence was (1) 87.5% (14/16) among smokers with more than 6.85 pack years and 7.4% (2/27) among smokers with fewer than 6.85 pack years (OR, 11.8), (2) 83.3% (10/12) among those with large resections (>0.85 kg) and 19.4% (6/31) among those with small resections (OR, 4.3), (3) 90% (9/10) among smoking patients with more than 6.85 pack years and a large resection and 50% (1/2) among patients with fewer than 6.85 pack years and a large resection (OR, 1.8), and (4) 83.3% (5/6) among smokers with more than 6.85 pack years and a small resection and 4 (1/25) among those with less than 6.85 pack years and a small resection (OR, 20.8).

Discussion

Among smokers, numerous factors are responsible for the increased risk of postoperative complications [5, 15–21]. Nicotine, nitric oxide, and carbon monoxide directly alter the wound healing process [22–25]. The dermal-subcutaneous vascular plexus of the flap is particularly susceptible to the vasoconstrictive effects of cigarettes [26–27]. Increased carboxyhemoglobin levels reduce the oxygen-carrying capacity of the blood [28]. Increased platelet adhesiveness leads to microangiopathic thromboses [29]. High levels of fibrinogen and hemoglobin cause an increased blood viscosity [30]. Finally, decreased fibrinolytic activity and direct endothelial injury contribute to a reduction in the local circulation [31]. In contrast, few studies to date have correlated the amount of tissue

Journal : Large 266 | Dispatch : 11-10-2007 | Pages : 7
Article No. : 9048 | LE | TYPESET
MS Code : 9048 | CP | DISK

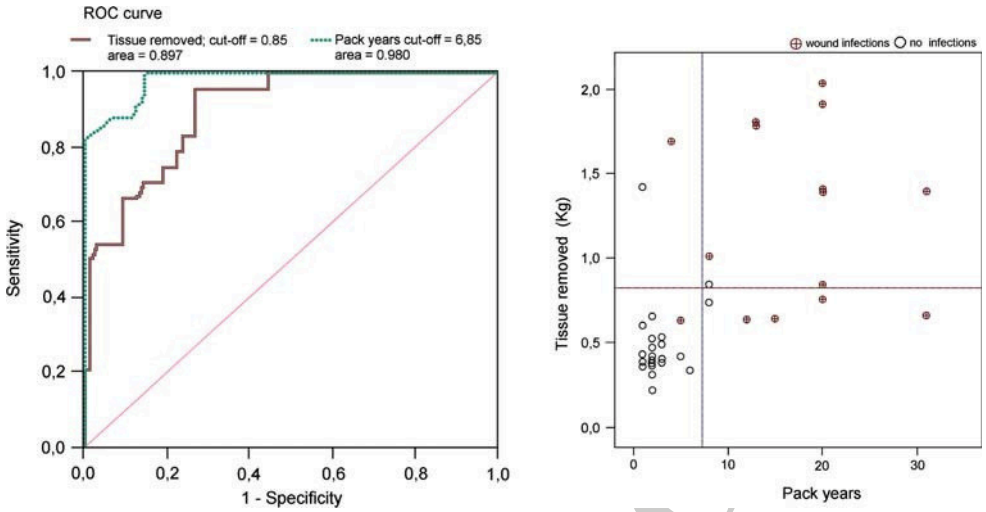

Fig. 2 *Left panel*: Area of ROC curves referring to cutoffs of tissue removed (all patients) and pack years (smokers). *Right panel*: Scatter plot with cutoff lines of infected smokers (*cross circles*) vs noninfected smokers (*black circles*)

removed with the incidence of postoperative complications in plastic surgery [1–4, 6].

Breast reduction is a technique susceptible to wound infections, with reported incidences of 3.6% to 25% [3, 12, 13]. Among smoking patients, the estimated risk for the development of postoperative wound complications is 1.6 to 3 times greater than among nonsmokers [5, 7]. The incidence of wound complications was 55.4% among smokers and 33.7% among nonsmokers [5]. A direct association between smoking and wound complications was found by the BRAVO study [4].

Our prospective trial found that postoperative infections are present in 27.6% (24/87) of patients and that 79.7% of these (n = 19) are superficial. Furthermore, 66.7% of infections (16/24) occurred in smokers, with 37.2% of smokers (16/43) experiencing this complication compared with 18.2% (8/44) of nonsmokers. These results perfectly match those already published and highlight the higher incidences of wound infections after breast reductions in smoking patients [1–4, 6].

Additionally, the smoking habit has conferred a twofold increase in the chance of wound infections developing after breast reductions, a value similar to that reported in literature [5, 7]. This value is lower than the risk reported for abdominoplasties (relative risk, 12) [32], possibly because the peculiar terminal vascularization of the abdominal flap makes it more sensitive to the chronic effects of cigarettes than breast tissue.

The analysis of infections showed that 19 of these were superficial and 5 were deep. The findings showed that 67.3% of superficial and 80% of deep infections occurred in smokers, even if the difference with nonsmokers was not significant (12/43 vs 7/44 and 4/43 vs 1/44). We believe that the number of infected patients is too low for certain conclusions to be drawn. Indeed, similar percentages of superficial and deep infections have occurred among smokers, suggesting that the presence of other cofactors are necessary for the microbiologic agents to penetrate deep into breast tissues. Our patients were highly selected and homogeneous according to the inclusion/exclusion criteria, and no particular differences predisposing to deep infections were present (e.g., diabetes). For this reason, we believe this issue is worth addressing in future studies aimed at preoperatively identifying patients at more risk for the development of wound infections so particular pre- and postoperative measures eventually can be adopted.

In our series, the analysis of smokers confirmed that the higher the estimated overall cigarettes smoked until surgery and the number of pack years, the greater the association with infections. Given the occurrence of 14 infections in smokers even with a smoke-free window of 4 weeks, we believe this period is not sufficient to prevent postoperative infections. Again, future studies need to address this issue specifically, possibly comparing patients with different smoke-free windows and using more accurate proofs of their abstinence (urine nicotine or blood carbon monoxide levels) to analyze the incidence of postoperative infections.

We also have analyzed the amount of tissue removed with surgery. Previous studies have demonstrated that the quantity of breast tissue resected correlates with an increased incidence of postoperative wound problems, especially dehiscence, and authors have suggested various cutoff values of 700 to 1,500 g. [3, 4, 6, 8–11]. Even in this case, a direct association between smoking and wound complications was found by the BRAVO study [4].

In our study we found that a cutoff value of 0.85 kg of tissue removed for both breasts corresponded to the greatest area of the ROC curve. According to this value, the analysis showed that postoperative infections were present in 70% of patients with large resections (14/20) and 14.9% of patients with small resections (10/67). These results

Journal : Large 266 | Dispatch : 11-10-2007 | Pages : 7
Article No. : 9048 | LE | TYPESET
MS Code : 9048 | CP | DISK

match perfectly with those already published that describe higher incidences of wound infections after large resections [3, 4–6]. Patients who underwent large resections had a 4.7-fold increase in the chance of developing wound infections, greater than the risk conferred by smoking (OR, 2). Furthermore, 52.6% of superficial infections (10/19) and 80% of deep infections (4/5) occurred with major resections, and in both cases, the difference with those occurring with small resections was significant (10/20 vs 9/67 and 4/20 vs 1/67). Our results suggest that the amount of tissue removed and smoking are independent factors, but that the increased risk of the former compared with the latter and the significant difference for superficial and deep infections present in cases with large resections but not in smokers indicate a more important role for the amount of tissue removed. Future studies are required to address this issue specifically.

Conclusions

The incidence of infections with our breast reductions was 27.6%. Most infections occurred in smoking people with major resections, confirming the importance of both factors in their occurrence. The relative risk conferred by smoking was 2, and that conferred by large resections was 4.7. If future larger studies confirm these data, surgeons could have a simple and easy method for stratifying patients according to the risk for the development of wound infections and thus could prescribe specific preventive measures.

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Journal : Large 266 | Dispatch : 11-10-2007 | Pages : 7
Article No. : 9048 | ☐ LE | ☐ TYPESET
MS Code : 9048 | ☑ CP | ☑ DISK

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Journal : **Large 266** Dispatch : **11-10-2007** Pages : **7**
Article No. : **9048** ☐ LE ☐ TYPESET
MS Code : **9048** ☑ CP ☑ DISK