Impact of Smoking Status in Free Deep Inferior Epigastric Artery Perforator Flap Breast Reconstruction: A Multicenter Study

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Abstract

Background Several patient-related factors have been identified with regard to the safety and efficacy of breast reconstructions. Using the largest database available in Europe, the presented study investigated the impact of cigarette smoking on deep inferior epigastric artery perforator (DIEP) free-flap breast reconstructions.

Methods In total, 3,926 female patients underwent 4,577 free DIEP-flap breast reconstructions after malignancies in 22 different German breast cancer centers. The cases were divided into two groups: nonsmokers (NS) and smokers (S). Impact of smoking on surgical complications, controlled for covariates, and cluster effects within the cancer centers were analyzed by using generalized linear mixed models.

Results Overall, there was no significant difference between the groups of patients regarding the rate of total flap loss. However, the rate of partial flap loss (0.9 vs. 3.2%, $p < 0.001$) and wound-healing disturbances requiring revision surgery (donor site: 1.5 vs. 4.0; recipient site: 1.3 vs. 3.6%, both $p < 0.001$) was significantly higher in smokers. Multivariable analysis identified smoking to be an independent risk factor for revision surgery ($p = 0.001$) and partial flap loss ($p < 0.0001$).

Conclusion Our findings suggest that successful free tissue transfer can be achieved in smokers despite higher rates of partial flap losses and wound-healing disturbances. However, patients with a history of smoking requiring DIEP flap reconstruction should be critically evaluated preoperatively, informed in detail about the higher risk of complications and encouraged to quit smoking prior to surgery.

Keywords
- DIEP flap
- smoking status
- breast reconstruction

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The harmful health effects of cigarette smoking have long been recognized by health care professionals. Yet, smoking continues to be a leading cause of preventable death.[1] It constitutes to major health economic expenses worldwide of over 5.7% of global health expenditure ($422 billion).[2] Several studies have compellingly demonstrated that the inhalation of cigarette smoke and its chemical compounds such as nicotine, carbon monoxide, or hydrogen cyanide is a causal factor for chronic cardiovascular disease or lung cancer and an independent risk factor for perioperative complications such as impaired wound healing.[3–5] Accordingly, smoking cessation has been shown to reduce postoperative complications significantly.[6]

The effects of cigarette smoking on microcirculation are of particular significance in microsurgery in general and breast reconstruction in particular. Understandably, diminished tissue oxygenation induced by carbon monoxide or nicotine-induced vasoconstriction[7] potentially weigh heavy in free flap reconstructions with vessel diameters for anastomosis often ranging between only 1 and 2 mm. Several studies have evaluated the effects of cigarette smoking on pedicled- and free tissue transfers and found a significant increase of complication rates.[8–12] However, none specifically focused on breast reconstructions with the free deep inferior epigastric artery perforator (DIEP) flap that is commonly used by plastic surgeons as the standard of care for autologous tissue transfer in this patient group.[13,14]

To determine whether smoking can be considered an independent risk factor in this specific patient group, we performed the largest comprehensive outcome analysis of 4,577 DIEP free-flap breast reconstructions across 22 different German breast cancer centers.

Methods

Design of the Online Registry

The German Society of Plastic, Reconstructive and Aesthetic Surgeons (DGPRÄC) initiated a prospective online registry in 2011 to systematically collect and transparently present the structure and quality of free flap breast reconstructions in Germany.[15] Ethical approval was obtained from the ethics commission of the Bavarian State Medical Association (156/17 S) and the Berlin Chamber of Physicians (Eth-V-Q/17) prior to initiation of the registry. Plastic surgical centers were certified by the DGPRÄC before data entry. Data of free flap breast reconstructions were entered intraoperatively, or immediately postoperatively, in a prospective manner and included patients' demographics, patients' characteristics, perioperative details, postoperative complications, and free flap outcome. After centers had completed entry of reconstructive interventions, they documented their progress for at least up to 3 months postoperatively in the database. Centers were audited and monitored with regard to the quality and stringency of the data entered in comparison with the hospital's internal documentation.[15]

Collection of Data

Between January 2011 and January 2019, 4,877 female patients underwent 5,804 free flap breast reconstructions after malignancies in 30 different German breast cancer centers. Of these, 22 centers performed DIEP flap reconstructions between January 2011 and January 2019 and were included in this study. In total, data of 3,926 female patients that underwent 4,577 free DIEP flap breast reconstructions were included and retrospectively screened. Patient information and identification were kept confidential at all times; data analysis was performed anonymously. The study included only women that received uni- or bilateral DIEP flap breast reconstruction due to breast cancer. In total, 629 patients received simultaneous bilateral DIEP flap reconstruction. If contralateral reconstruction was achieved using a different flap type, we only included the DIEP flap in the study. "Salvage" DIEP flaps in women with complications after reconstruction using other free flaps or implant-based reconstructions (e.g., infection, extrusion, or severe pain/cosmetic failure caused by capsule formation) were also included in this study. To analyze a uniform group of patients, women that received breast reconstruction using a different reconstructive approach (i.e., muscle-sparing transverse rectus abdominis, superior and inferior gluteal artery perforator, transverse musculocutaneous gracilis, or other flaps) were excluded from the study. Other than that, there were no distinct exclusion criteria. However, a complete dataset for every patient to be included was mandatory. The completeness of inclusion was verified by an auditing team. The cases were then divided into two groups according to patients smoking status: nonsmokers (NS) and smokers (S) group. Smokers were defined as patients with a current history of smoking in the year before admission to surgery, whereas the nonsmoker group included patients that had never smoked or had quit smoking at least 12 months prior to surgery. Surgical complications were accounted for, and the groups were then compared. Clinical outcome analysis was performed by plastic surgeons at the individual centers. The outcomes investigated included total flap loss, partial flap loss, unexpected, or emergent revision surgery and reasons for revision surgery (arterial and venous thrombosis, surgical site infection, hematoma donor, or recipient site), wound-healing disturbances, and any medical complications (i.e., deep vein thrombosis, pulmonary embolism, myocardial infarct, and others) that occurred postoperatively.

Statistical Considerations

Sample size: No *a priori* sample size calculation was performed for this study for two reasons. The expected number of patients in the chosen time interval was high enough for detection of any clinically relevant difference without having the risk of being underpowered. There was no primary endpoint for a sample size calculation, since this is an exploratory trial with several different endpoints.

Statistical methods: Data were shown as mean (standard deviation) or as absolute and relative frequencies. A *t*-test or a Chi-squared test of independence was used to determine differences between smokers and nonsmokers. The influence of smoking on different outcomes (revision surgery, partial flop loss, and total flap loss) was further analyzed by using generalized linear mixed models. The known risk factors

diabetes mellitus (DM), coagulopathy, immunosuppressive therapy, neoadjuvant chemotherapy, tamoxifen therapy, and neoadjuvant radiation therapy were added as additional covariates. Additionally, to account for clinic specific cluster effects, the surgeon nested within the cancer clinic was added as a random factor to the model. A p-value <0.05 was considered statistically significant for all analyses. All analyses were performed using SAS (Version 9.4, The SAS institute, Cary, NC) and the GLIMMIX procedure.

Results

Demographics and Patient Characteristics

Patients' characteristics are portrayed in ►**Table 1**. The NS group included 3,516 patients (4,101 free flaps, mean age = 51.61 years, standard deviation [SD]: 33.24) and the S group included 410 patients (476 free flaps, mean age = 48.66 years, SD: 8.84). Assessment of comorbidities showed that a significantly higher number of patients in the S

Table 1 Patient characteristics of smokers and nonsmokers

Patient demographics	Nonsmoker	Smoker	*p*-Value
Patients, *n*	3,516	410	
Free flaps, *n*	4,101	476	
Age (y)			
Mean (SD)	51.61 (33.24)	48.66 (8.84)	0.054
BMI (kg/m^2)			
Mean (SD)	26.29 (4.46)	26.22 (4.29)	0.733
Comorbidities, *n* (%)			
Diabetes mellitus	104 (2.5)	21 (4.4)	0.026
Coagulopathy[a]	104 (2.5)	21 (4.4)	0.026
Abdominal scar > 10 cm, *n* (%)	167 (4.1)	25 (5.3)	0.274
Family history of breast and/or ovarian cancer in FDRs, *n* (%)	1,059 (25.8)	132 (27.7)	0.399
Genetic disposition, *n* (%)[b]	624 (15.2)	73 (15.3)	0.999
Chemotherapy within last 6 months, *n* (%)[c]	2,357 (57.5)	248 (52.1)	0.028
Chemotherapy later than 6 months, *n* (%)[d]	1,986 (48.4)	220 (46.2)	0.387
Immunosuppressive therapy, *n* (%)[e]	26 (0.6)	8 (1.7)	0.025
Tamoxifen therapy, *n* (%)[f]	444 (10.8)	40 (8.4)	0.121
Neoadjuvant radiation therapy, *n* (%)	1,467 (35.8)	175 (36.8)	0.669
Etiology, *n* (%)			0.02
Status after mastectomy	1,409 (41.1)	146 (35.4)	
DCIS	157 (4.6)	23 (5.6)	
Primary carcinoma	395 (11.5)	41 (10.0)	
Familial risk[g]	243 (7.1)	19 (4.6)	
Complications after other reconstruction[h]	704 (20.5)	109 (26.5)	
Benign tumor	38 (1.1)	9 (2.2)	
Status after BCT	282 (8.2)	39 (9.5)	
Tumor recurrence	108 (3.1)	14 (3.4)	
other	93 (2.7)	12 (2.9)	

Abbreviations: BCT, breast conserving therapy; BMI, body mass index; DCIS, ductal carcinoma in situ; FDR, first degree relatives; SD, standard deviation.

Note: Comparison of patients' demographics, comorbidities, risk factors for breast cancer, systemic breast cancer treatment, and reasons (etiology) for deep inferior epigastric artery perforator flap reconstruction. Percentages for each item were calculated based on the number of free flaps in each group.

[a]Self-reported clinical history of any derangement of hemostasis resulting in impaired clot formation.

[b]No positive test but a positive family history for breast cancer.

[c]Neoadjuvant chemotherapy within the last 6 months prior to breast reconstruction.

[d]Neoadjuvant chemotherapy more than 6 months prior to breast reconstruction.

[e]Immunotherapy using targeted antibodies for tumors that overexpress human epidermal growth factor receptor 2 protein receptor.

[f]Patients with hormone-receptor positive breast cancer receiving tamoxifen therapy.

[g]Risk-reducing mastectomy due to pathogenic mutation identified in genetic test for familial/hereditary breast cancer.

[h]Complications after previous reconstructive procedure (i.e., implant reconstruction).

group suffered from DM (2.5% NS vs. 4.4% S, $p = 0.026$) and coagulopathy (2.5% NS vs. 4.4% S, $p = 0.026$). Groups were comparable with regard to mean BMI and prevalence of abdominal scars.

Risk factors for breast cancer, such as genetic disposition and family history of breast and/or ovarian cancer in first degree relatives, were distributed evenly between the two groups.

With regard to systemic therapy for breast cancer, patients with a history of smoking showed a significantly higher rate of immunotherapy using targeted antibodies (0.6% NS vs. 1.7% S, $p = 0.025$). Conversely, neoadjuvant chemotherapy was administered more frequently in the NS group (within 6 months prior to reconstruction: 57.5% NS vs. 52.1% S, $p < 0.028$; more than 6 months prior to reconstruction: 48.4% NS vs. 46.2% S, $p < 0.387$). In addition, patients in the NS group received tamoxifen therapy more frequently, however, without showing a significant difference (10.8% NS vs. 8.4% S; $p < 0.121$). Neoadjuvant radiation therapy showed no significant difference between both groups ($p = 0.669$).

All sites investigated performed DIEP flaps on smokers. However, the distribution of smokers and nonsmokers varied significantly among the 22 centers (►**Table 2**; $p < 0.001$).

Table 2 Distribution of deep inferior epigastric artery perforator flaps performed in smokers and nonsmokers among the 22 centers

Klinik ID	Nonsmoker, *n* (%)	Smoker, *n* (%)	Total, *n*	*p*-Value <0.001
1	208 (87.4)	30 (12.6)	238	
2	38 (73.1)	14 (26.9)	52	
3	141 (92.2)	12 (7.8)	153	
4	55 (77.5)	16 (22.5)	71	
5	38 (97.4)	1 (2.6)	39	
6	46 (90.2)	5 (9.8)	51	
7	623 (97.6)	15(2.4)	638	
8	57 (73.1)	21 (26.9)	78	
9	10 (90.9)	1 (9.1)	11	
10	872 (93.5)	61 (6.5)	933	
11	61 (78.2)	17 (21.8)	78	
12	416 (89.3)	50 (10.7)	466	
13	170 (84.6)	31 (15.4)	201	
14	105 (86.8)	16 (13.2)	121	
15	44 (88.0)	6 (12.0)	50	
16	118 (85.5)	20 (14.5)	138	
17	65 (89.0)	8 (11.0)	73	
18	55 (87.3)	8 (12.7)	63	
19	729 (86.5)	114 (13.5)	843	
20	145 (89.0)	18 (11.0)	163	
21	29 (96.7)	1 (3.3)	30	
22	76 (87.4)	11 (12.6)	87	
Total, *n* (%)	4,101 (89.6)	476 (10.4)	4,577	

Perioperative Details and Postoperative Complications

Mean operative time was significantly shorter in the NS group (316.04, SD = 26.17 NS vs. 340.66, SD = 129.60 S minutes; $p < 0.001$), whereas mean ischemic time did not differ significantly (50.71, SD = 26.08 NS vs. 51.60, SD = 23.87 S minutes; $p = 0.478$). In the NS group, we found that 3.4% ($n = 141$) of reconstructions were performed as teaching operations, compared with 5.7% ($n = 27$) in the S group ($p = 0.02$). Mean length of hospital stay was similar in both groups (8.50, SD = 11.95 NS vs. 8.25, SD = 4.97 S days; $p = 0.65$). All perioperative characteristics are summarized in ►**Table 3**.

Overall, smokers and nonsmokers showed no significant difference with regard to the rate of total flap loss (2.0% NS vs.

Table 3 Perioperative characteristics according to smoker status

Perioperative characteristics	Nonsmoker	Smoker	*p*-Value
Free flaps, *n*	4,101	476	
Type of reconstruction, *n* (%)			0.173
Immediate	1,030 (25.1)	106 (22.3)	
Secondary	3,071 (74.9)	370 (77.7)	
Reconstructed side, *n* (%)			
Right	1,390 (33.9)	170 (35.7)	
Left	1,507 (36.7)	169 (35.5)	
Both	1,204 (29.4)	137 (28.8)	
Teaching operation, *n* (%)[a]	141 (3.4)	27 (5.7)	0.02
Operation time (min)			
Mean (SD)	316.04 (127.51)	340.66 (129.60)	<0.001
Ischemia time (min)			
Mean (SD)	50.71 (26.08)	51.60 (23.87)	0.478
Recipient vessels, *n* (%)			
Internal mammary	3,247 (79.2)	436 (91.6)	<0.001
Thoracodorsal	679 (16.6)	25 (5.3)	<0.001
Other	175 (4.3)	15 (3.2)	0.248
Postoperative mobilization, *n* (%)			<0.001
Postoperative day 1	3,005 (73.3)	288 (60.6)	
Postoperative day 2	676 (16.5)	97 (20.4)	
Postoperarive day 3	111 (2.7)	15 (3.2)	
Postoperative day > 3	303 (7.5)	75 (15.8)	
Hospital stay (d)			
Mean (SD)	8.50 (11.95)	8.25 (4.97)	0.65

Abbreviation: SD, standard deviation.

Note: Percentages for each item are calculated based on the number of free flaps in each group.

[a]Operation performed by a resident or junior attending that was supervised by senior attending staff.

Table 4 Postoperative complications

Postoperative complications	Nonsmoker	Smoker	*p*-Value
Free flaps, *n*	4,101	476	
Total flap loss, *n* (%)	82 (2.0)	10 (2.1)	1
Partial flap loss, *n* (%)	36 (0.9)	15 (3.2)	<0.001
Unexpected/emergent revision surgery, *n* (%)	377 (9.2)	48 (10.1)	0.526
Venous thrombosis	109 (2.7)	14 (2.9)	0.832
Arterial thrombosis	64 (1.6)	10 (2.1)	0.489
Infection donor site	22 (0.5)	1 (0.2)	0.541
Infection recipient site	17 (0.4)	3 (0.6)	0.758
Hematoma donor site	35 (0.9)	2 (0.4)	0.466
Hematoma recipient site	130 (3.2)	18 (3.8)	0.564
Wound-healing disturbances requiring revision surgery, *n* (%)			
Donor site	61 (1.5)	19 (4.0)	<0.001
Recipient site	53 (1.3)	17 (3.6)	<0.001
Medical complications, *n* (%)	261 (6.4)	33 (6.9)	1

Note: Percentages for each item are calculated based on the number of free flaps in each group.

2.1% S; $p = 1$) and the need for unexpected/emergent revision surgery (9.2% NS vs. 10.1% S; $p = 0.526$). However, partial flap loss (0.9% NS vs. 3.2% S; $p < 0.001$), and wound-healing disturbances of the donor (1.5% NS vs. 4.0% S; $p < 0.001$) and recipient site (1.3% NS vs. 3.6% S; $p < 0.001$) requiring revision surgery occurred significantly more often in patients with a history of smoking. The rate of medical complication was similar between the two groups. Postoperative complications are shown in ►**Table 4**.

Multivariable analysis was performed for all patients requiring unexpected or emergent revision surgery including revision surgery due to wound-healing disturbances, partial flap loss and total flap loss (►**Table 5**). Of all risk factors investigated, smoking was identified as the only factor significantly increasing the odds for revision surgery (odds ratio [OR]: 1.59, 95% confidence interval [CI]: 1.20–2.11, $p = 0.001$). For partial flap loss, smoking (OR: 3.66, 95% CI: 1.94–6.90, $p < 0.0001$) and neoadjuvant radiation therapy (OR: 2.06, 95% CI: 1.13–3.77, $p = 0.019$) were identified as significant risk factors. Smoking did not significantly increase the odds for total flap loss (OR: 1.23, 95% CI: 0.62–2.43, $p = 0.553$); however, diabetes was identified as a significant risk factor for this outcome (OR: 3.42, 95% CI: 1.59–7.35, $p = 0.002$).

Discussion

Cigarette smoking continues to be a major risk factor for early death and disability.[16] It is known to have detrimental effects across a wide range of surgical disciplines and procedures, including many common plastic surgical procedures. Adverse outcomes with regard to smoking have been described, especially for procedures with extensive soft tissue dissection such as face lift[17] and abdominoplasty;[18] in addition to several procedures in breast surgery such as breast reduction, mastopexy, or augmentation-mastopexy.[19,20] Smoke inhalation negatively affects microcirculation[21] and is thus of high significance in microsurgery and free flap transfer.[22] Currently, studies suggest that smoking-related complications can be reduced by preoperative cessation for at least 4 weeks.[23–26]

Using the largest available database in Europe, the presented study analyzed the impact of cigarette smoking on outcomes and complications of 4,577 breast reconstructions with DIEP free flaps. Our data add significant evidence to underline the detrimental effect of cigarette smoking on postoperative complications by demonstrating that smokers suffered from significantly higher rates of partial flap loss and wound-healing disturbances requiring revision surgery at donor and recipient sites, as compared with nonsmokers. The observed increase in complications did, however, not translate into a significant increase of total flap loss between the two groups, thereby also reinforcing current literature. In line with our results, Ehrl et al shortly publicized a retrospective analysis of 969 microvascular free flap reconstructions and found that minor and major complications were

Table 5 Generalized linear mixed models of risk-factors for revision surgery (including unexpected, emergent revision surgery, and revision surgery due to wound healing disturbances), partial flap loss, and total flap loss

	Revision surgery		Partial flap loss		Total flap loss	
Risk-factor	OR (95% CI)	*p*-Value	OR (95%CI)	*p*-Value	OR (95% CI)	*p*-Value
Smoking	1.59 (1.20–2.11)	0.001	3.66 (1.94–6.90)	<0.0001	1.23 (0.62–2.43)	0.553
Diabetes mellitus	1.18 (0.68–2.04)	0.549	2.46 (0.84–7.19)	0.100	3.42 (1.59–7.35)	0.002
Coagulopathy	1.45 (0.74–2.82)	0.277	[a]		2.56 (0.77–8.55)	0.126
Immunosuppressive therapy	0.48 (0.11–2.08)	0.324	[a]		1.69 (0.21–13.51)	0.619
Neoadjuvant chemotherapy	0.87 (0.70–1.08)	0.205	0.58 (0.32–1.08)	0.084	1.15 (0.72–1.84)	0.564
Tamoxifen therapy	1.10 (0.81–1.50)	0.536	1.10 (0.45–2.68)	0.829	1.24 (0.66–2.32)	0.509
Neoadjuvant radiation therapy	1.20 (0.97–1.49)	0.088	2.06 (1.13–3.77)	0.019	1.17 (0.74–1.85)	0.511

Abbreviations: CI, confidence interval; OR, odds ratio.
[a]Excluded from the analysis due to a limited number of events of the endpoint.

increased regarding all examined parameters in smokers, while cigarette smoking did not have significant effects on the overall outcomes of microsurgical free flap reconstructions, that is, free flap failure.[8] In contrast to their findings, we found that mean operative time was significantly longer in the S group in our study population of DIEP flaps. Unfortunately, our data provide no conclusive evidence for this finding. Notably, our data show that a significantly higher amount of breast reconstructions was performed as teaching operations (supervised by senior attending staff) in the S group. Arguably, this could account at least in part for the longer operative times observed.

Cigarette smoke contains several toxic chemical agents that lead to endothelial cell damage and peripheral vasoconstriction as well as micro- and macroangiopathy.[27–29] Eventually, this can cause an increase in platelet aggregation and ultimately arterial or venous thrombosis.[30,31] In microsurgical free flap transfers, arterial and venous thrombosis continue to rank highest among the main complications. While continuous improvement in microsurgical techniques and technology have simplified microsurgical anastomoses and led to a continuous improvement of free flap outcomes; 5 to 25% of transferred flaps require surgical revision because of circulatory compromise.[32,33] Several patient-related factors have been identified with regard to the safety and efficacy of free flap reconstructions, and patient evaluation is therefore critical preoperatively. In this regard, diabetes, age, BMI, and smoking are considered as risk factors for outcome after microsurgical reconstructions.[34–39] Interestingly, previous studies reviewing anastomotic patency rates and overall survival of free-tissue transfers found no significant differences in smokers when compared with nonsmokers.[9,40–42] Accordingly, our study reports no significant difference in the rate of arterial or venous thrombosis between the two groups. However, the increased rates of partial flap loss and wound-healing disturbances in smokers may be attributed to a decrease of perfusion in the most vulnerable distal regions of the vascular territories, which becomes especially apparent in tissue that has limited vascular supply, as is the case for free flaps after anastomosis. Concurrently, numerous previous articles have linked cigarette smoking to tissue necrosis, reduced wound epithelialization, and scarring.[23,43–45]

A major strength of this study lies within the large sample size of 3,926 female patients and 4,577 DIEP flap breast reconstructions after malignancies in 22 different German breast cancer centers between January 2011 and January 2019. Patients were divided into two groups according to smoker status. We thus compared 4,101 reconstructions in nonsmokers with 476 reconstructions in smokers. This series allows us to draw significant conclusions regarding the impact of cigarette smoking on outcome and complications of DIEP tissue transfers for breast reconstruction, and to our knowledge, no previous studies analyzed a series as large in this specific patient group. Procedures across the 22 breast cancer centers were performed by different microsurgeons, which arguably is a strength and limitation at the same time. Anastomotic technique and the grade of surgeon is regarded as key when evaluating free flap outcomes and insufficient anastomosis could impact complication rates. As the majority of procedures were performed by board-certified plastic surgeons at each center, we assumed that sufficient anastomosis technique was applied in all cases. This taken into account, flaps being performed by numerous different surgeons may allow to further extrapolate the results. Arguably, the unequal distribution of comorbidities such as DM or coagulopathy, prevalence status of chemo- and immunosuppressive therapy, and therapy with procoagulatory medication such as tamoxifen between the investigated groups is a limitation of the study. Inhomogeneity in both groups with regard to aforementioned characteristics could account, at least in part, for differences observed in complications between smokers and nonsmokers. Exemplary, DM is known to severely comprise wound healing and accounts for complications in all types of breast reconstruction.[46,47] Patients suffering from coagulopathies show comparably high revision and flap loss rates.[48] The impact of neoadjuvant chemotherapy on complications in microvascular surgery is controversially discussed.[49–51] Studies have reported an increase of microvascular complications and wound-healing disturbances associated with radiation therapy.[52–54] Multivariable analysis was therefore performed to address potential confounding factors. Importantly, smoking was identified as the only factor significantly increasing the odds for revision surgery. For partial flap loss, both smoking and neoadjuvant radiation therapy were identified as independent significant risk factors. While smoking did not significantly increase the odds for total flap loss, diabetes was identified as a significant risk factor for this outcome. Further detailed evaluation of this finding is, however, outside the scope of this study.

Taken together, our study provides evidence of the feasibility of DIEP free flap transfer in smokers, while simultaneously demonstrating an increased risk of postoperative complications in this patient group.

Conclusion

This study analyzed the largest German series of microsurgical breast reconstructions using DIEP flaps, with regard to the impact of cigarette smoking on flap outcome and complications in this patient group. While total flap failure was comparable between smokers and nonsmokers, a significantly higher number of patients with a history of cigarette smoking suffered from partial flap loss and wound-healing disturbances requiring revision surgery. Thus, despite also being feasible in patients with a history of smoking, women requiring DIEP flap reconstruction should be critically evaluated preoperatively, informed in detail about the higher risk of complications and encouraged to quit smoking prior to surgery.

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Conflict of Interest
None declared.

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