Risk Factor Analysis for Flap and Donor Site Related Complications in 1274 DIEP Flaps – Retrospective Single Center Study

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Abbreviations:

DIEP: deep inferior epigastric artery perforator;
BMI: body mass index;
ms: muscle-sparing;
DIEA: deep inferior epigastric artery;
SIEV: superficial inferior epigastric vein;

Rezumat

Analiza factorilor de risc pentru lambou și complicațiile legate de locul donatorului în 1274 de reconstrucții cu lambou de tip DIEP - studiu retrospectiv unicentric

Context: Cancerul de sân este cel mai frecvent cancer care afectează femeile din întreaga lume. În Germania, în aproape 70% din cazuri, femeile necesită o mastectomie completă și doresc reconstrucția sânelor, care este deosebit de dificilă atunci când sânul a fost iradiat anterior. Lamboul cu pedicul din artera epigastrică inferioară profundă (deep inferior epigastric artery perforator - DIEP) este standardul de aur pentru reconstrucția autologă a sânelor și prezintă o rată generală de complicații scăzută. Acest studiu retrospectiv își propune să sublinieze siguranța procedurii, dar evidențiază și potențialii factori de risc pentru apariția necrozei la nivelul marginii și grăsimii lamboului într-o serie de 1274 de lambouri DIEP din centrul nostru.

Pacienți și metode: Între iulie 2004 și decembrie 2014 au fost efectuate 1274 de reconstrucții mamare autologe cu lambou DIEP la 1124 de paciente. Analiza retrospectivă a factorilor de risc a inclus vârsta, IMC, fumatul, chimioterapia și/sau radioterapia și comorbiditățile. Pacientele au fost urmărite în medie timp de 24 de luni.

Rezultate: Din 1274 de reconstrucții mamare cu lambou DIEP, 150 au fost reconstrucții bilaterale. În 785 de cazuri, indicația principală a fost mastectomia anterioară, urmată în 265 de cazuri de reconstrucție bazată pe implant. Rata totală de pierdere a

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lamboului a fost de 0,6%. Pacienții cu un IMC mai mare și fumătorii au avut complicații semnificativ mai numeroase decât restul cohortei. Pacienții vârstnici (> 65 de ani), pacienții cu diabet zaharat și cei care au fost supuși chimioterapiei / radioterapiei nu au prezentat rate de complicație mai mari. *Concluzie:* Operația cu lambou DIEP este o metodă bine stabilită pentru reconstrucția autologă a sânelui cu o rată scăzută de complicații. Cu toate acestea, caracteristicile pacienților în ceea ce privește factorii de risc trebuie să fie luate în considerare în evaluarea prognosticului și pentru obținerea unor rezultate satisfăcătoare pe termen lung.

Cuvinte cheie: sân, cancer de sân, reconstrucția autologă a sânelui, reconstrucția sânelui, lambou DIEP

Abstract

Background: Breast cancer is the most common cancer affecting women worldwide. In Germany, in almost 70% of cases, women require a complete mastectomy and wish for breast reconstruction which is especially difficult when the breast was previously irradiated. The DIEP flap is then the gold standard for autologous breast reconstruction and shows an overall low complication rate. This study aims to underline the safety of the procedure yet point out potential risk factors for flap edge and fat necrosis in a retrospective series of 1274 DIEP flaps in our center.

Patients and Methods: 1274 autologous breast reconstructions with the DIEP flap were performed in 1124 patients between July 2004 and December 2014 in our department. Retrospective risk factor analysis included age, BMI, smoking, chemotherapy and/or radiotherapy and comorbidities. Mean follow-up constituted out of 24 months.

Results: Out of 1274 free DIEP flap breast reconstructions, 150 were bilateral reconstructions. In 785 cases the primary indication was previous mastectomy, followed by prior implant-based reconstruction in 265 cases. The total flap loss rate was 0.6%. Patients with a higher BMI and smokers had significantly higher complication rates than the rest of the cohort. Elderly patients (> 65 years), patients with diabetes and ones who had undergone chemo-/ radiotherapy did not present with higher complication rates.

Conclusion: The DIEP flap surgery is a well-established method for autologous breast reconstruction with a low complication rate. Yet patient characteristics in terms of risk factors need to be taken into account for result prognosis and satisfactory long-term reconstructive results.

Key words: breast, breast cancer, autologous breast reconstruction, breast reconstruction, DIEP flap

Introduction

Breast cancer is the most common cancer affecting women in Germany, with an incidence rate of around 75000 women per year. One in four women is younger than 55 years at diagnosis and one in ten women is younger than 45 years [Robert Koch Institute, Centre for Cancer Registry Data, (1)]. The

decision to perform a mastectomy (surgical removal of the glandular tissue and/or skin-envelope of the breast) is guided by the tumor stage, an unfavourable breast size to tumor size ratio and the presence of multifocal or inflammatory carcinoma (2,3) or the recurrence after breast conservative surgery. Carriers of the heterozygous BRCA 1/2 gene mutation (BRCA CAnceR) or other gene mutations have

an increased risk of developing breast and/or ovarian cancer during the course of their lives (4-6). They can reduce their risk by undergoing a bilateral mastectomy. In most cases women decide to reconstruct their breasts either with implants or autologous tissue which is stated to significantly improve the patient's quality of life (7). The latter is mostly performed in women that underwent additional radiotherapy and thus have a high risk of developing painful capsular contracture. Autologous reconstruction results in a breast which moves more naturally, mimics weight fluctuation and natural ageing processes similar to natural breasts but most importantly is not influenced by side effects of radiotherapy such as dermatitis and the development of fibrotic and scar tissue. In 1982 the autologous breast reconstruction consisted out of the transfer of a pedicled transverse rectus abdominis muscle, the (TRAM) flap (8), with a skin island to the thoracic wall to reconstruct a breast. Yet, due to advancements in the field of microsurgery, the first free microvascular TRAM flap was performed in 1989 (9). Due to this approach, the flap consisted only of adipocutaneous tissue from the lower abdomen without the inclusion of the rectus abdominis muscle. The vessels used for the tissue transfer were the inferior deep epigastric artery and the inferior epigastric vein (DIEA/DIEV) (10). Moreover, the new technique preserved the segmental innervation of the rectus muscle. Finally, in 1994 the first deep inferior epigastric artery perforator (DIEP) flap evolved (11,12). This study shows that up to date the DIEP flap is still a safe and reliable procedure for autologous breast reconstruction with a low rate of complications. The retrospective single-center study focuses on the risk factors (age, BMI, diabetes mellitus, smoking, chemo-/radiotherapy) and their potential association with complications in 1274 DIEP flap procedures performed in our center. We present the results of this procedure carried out over the past 10 years in our department in an interdisciplinary breast center setting.

Patients and Methods

Patient Selection

1124 patients were operated with the DIEP flap procedure from July 2004 to December 2014 at the Sana Hospital in Düsseldorf-Gerresheim. The data was evaluated retrospectively. Patients who underwent a DIEP flap procedure for autologous breast reconstruction were included into the study according to the following inclusion criteria: primary reconstruction after modified radical mastectomy and/ or prophylactic mastectomy for gene mutation (e.g. BRCA1/2, etc.), foreign body sensation and/or capsular fibrosis after implant-based reconstruction or cosmetically unsatisfactory outcome after breast conservative surgery.

Patients were excluded whose rectus abdominis muscle had to be removed in a significantly larger portion due to perforator insufficiency in the sense of a muscle-sparing (ms) TRAM or TRAM flap or who had previous delay surgeries (ligature of the inferior epigastric vascular system in preparation for a pedicled TRAM flap) as well as serious comorbidities. Additionally patients were excluded whose Angio-CT scan of the abdominal wall did not show any sufficient vascular supply to the abdominal wall due to previous abdominal surgeries. Data collection was carried out using a preoperative and postoperative documentation algorithm. The patients presented to our outpatient department for follow-up at 2 weeks, 6 weeks, 3 months, 1 year and 4 years after surgery or were questioned by telephone interview. The mean follow-up time was 24 months (12–48 months).

Risk Factor Analysis

The study cohort was retrospectively analyzed upon commonly known risk factors such as BMI (body mass index), smoking, previous chemotherapy and/or radiation therapy, age, and diabetes mellitus. The patients were divided into a risk factor subgroup that features only one risk factor. The postoperative

complications of the patients were recorded and divided into flap-related complications such as Total flap loss, partial flap loss, revision, flap edge necrosis, fat necrosis, breast haematoma and the abdominal site (harvest site) complications such as abdominal haematoma, impaired abdominal wound healing, seroma and abdominal wall hernia. Each risk factor subgroup was analyzed under the aspect of the flap – and abdominal site complications to gain insight into which complication is more common with which risk factor.

Anatomy and Surgical Technique

Surgery is carried out under general anesthesia with the patient in a supine position. The shape of the abdominal incision is similar to that used for an abdominoplasty – an ellipsoidal incision on the lower abdomen. The surgery is performed with a two-team approach, i.e., by two surgical teams each consisting of a surgeon and assistant; one to harvest the flap and the other one to perform the microvascular anastomosis. The abdominal wall is perfused by the superior, inferior and superficial epigastric arteries, which communicate with one another. Multiple perforator vessels arise along the course of the deep inferior epigastric artery (DIEA), pass the rectus abdominis muscle and give off branches to the hypodermis to supply the skin and the subdermal layers with blood. The perforator vessels usually provide the arterial supply or venous drainage of the entire flap. Preoperatively all patients undergo an angio-CT to visualize the perforator vessels in order to pinpoint their location. Upon this diagnostic tool the course and caliber of the perforators can be determined preoperatively and a preliminary choice of perforator can be performed which will be verified during the course of the surgery. The abdominal flap is dissected down to the abdominal wall fascia, under preserving the superficial inferior epigastric vein (SIEV) to up to 5 cm for venous supercharging in the event of venous congestion. The dissection is further continued by using bipolar forceps along the epifascial

plane from lateral to medial, preserving the perforator vessels. After selecting the perforator for the adipocutaneous flap, it is then liberated from the rectus abdominis muscle until the inferior epigastric artery and vein are reached while ensuring that segmental innervation is preserved. For breast reconstruction, the preferred recipient vessels are the internal mammary vessels (internal mammary artery/internal mammary vein, IMA/IMV) which take a parasternal and retrocostal course. Vascular anastomoses are performed at the level of the third or fourth rib for which approximately 3 cm of the rib have to be dissected at the sternocostal joint.

Statistical Analysis

Statistical analysis of subgroups was performed with the Fisher's Exact test and χ^2 test using Microsoft Excel 2010 (Microsoft Corporation, Redmond, USA) and IBM SPSS statistics (v. 19.0). Statistical significance was reached at a p-value of < 0.05 . Risk factors were determined as: age, BMI, smoking, diabetes mellitus, chemo- and radiotherapy. The outcome parameters were defined as the occurrence of complications.

Results

General Study Population

1274 DIEP flap reconstruction procedures were performed in 1124 women between July 2004 and December 2014 in our department of plastic and reconstructive surgery at the SANA Clinic in Düsseldorf. The mean patient age was 50 (SD ± 8.70) years. The mean BMI of the patient cohort was 25.6 (SD ± 3.8) kg/m² from which 0.5% of patients were underweight with a BMI < 18.5 kg/m². A total of 622 patients (55.2 %) had a BMI > 25 kg/m² from which 40.2 % were overweight and 15.2% were obese with a BMI > 40 kg/m².

The mean duration of surgery was 312 (SD ± 390.52) minutes with a mean duration for unilateral procedures of 305 minutes and for bilateral flaps of 436 minutes. 133 patients

Table 1. Patient demographics

Patient characteristics	Total number of patients (n = 1124)
Age	50 (SD ± 8.70)
BMI (kg/m ²)	25.6 (SD ± 3.8)
Underweight (< 18.5 kg/m ²)	6 (0.5%)
Normal weight (18.5 ≤ 25 kg/m ²)	496 (44.1%)
Overweight (25 ≤ 30 kg/m ²)	452 (40.2%)
Obese (30 ≥ 40 kg/m ²)	170 (15.2%)
Duration of surgery (minutes)	312 (SD ± 390.52); [305 uni-, 436 bilateral]
Smoker	n = 133 (11.8%)
Diabetes	n = 5 (0.4%)
Post-chemotherapy	n = 763 (67.9%)
Post-radiotherapy	n = 662 (58.9%)

BMI: Body-Mass-Index, SD: Standard deviation

were smokers and only 5 had diabetes Typ 1. Chemo – and radiotherapy were obtained by 763 patients and 662 patients respectively (*Table 1*). The majority of reconstructions were performed in patients who already had a modified radical mastectomy (MRM) (69.8%). The second most common cause were complications after an implant-based reconstruction in 265 cases with 144 cases having a symptomatic capsular fibrosis and 78 cases an aesthetically unsatisfactory result. 43 cases had a combination of both of the previously mentioned. In 67 cases a DIEP reconstruction was indicated due to unsatisfactory outcomes after breast conserving therapy (BCT) and 8 cases after prior latissimus dorsi flap reconstruction with an implant (*Table 2*). More than three quarters of surgeries were secondary unilateral procedures with 933 patients, followed by 109 patients that obtained secondary bilateral reconstructions, most of which were carried out due to prophylactic breast removal in women with BRCA1/2 gene mutations (*Table 3*). The total number of complications is 148 (11.7%) in 1274 DIEP flap procedures.

General Total Complications

Looking at the flap related complications, fat necrosis occurred in 47 cases and a flap edge necrosis of a total volume < 10% of the flap

Table 2. Indications for autologous breast reconstruction

Indications	Per cent	n
1. After MRM	69.8%	785
2. After BCS with unpleasing result	6.0%	67
3. After LD and Implant Reconstruction	0.6%	7
4. After Implant-based Reconstruction	23.6%	265
a) Symptomatic capsular contracture	54.4%	144
b) Aesthetically unpleasing result	29.4%	78
c) Both (a and b)	16.2%	43

MRM: modified-radical mastectomy; BCS: Breast Conservativ Surgery; LD: Latissimus dorsi

Table 3. Choice of reconstruction

Reconstruction	Per cent	n
1. Primary unilateral	3.6%	41
2. Secondary unilateral	83.0%	933
3. Primary unilateral and contralateral secondary	2.1%	23
4. Primary bilateral	1.6%	18
5. Secondary bilateral	9.7%	109

Table 4A. Total number of complications

Patients (n)	1124
DIEP-flaps	1274
Complications	%
Total complications	148 11.7%
Total flap loss	8 0.6%
Partial flap loss > 20% of the flap	12 0.9%
Insufficient arterial supply	1 0.1%
Inadequate venous drainage	10 0.8%
Flap edge necrosis < 10% of the flap	32 2.5%
Breast haematoma	17 1.3%
Fat necrosis	47 3.6%
Abdominal haematoma	5 0.4%
Abdominal wall hernia	3 0.2%
Abdominal wound healing difficulties	7 0.5%
Abdominal seroma	6 0.5%

occurred in 32 cases. 17 patients presented with a breast haematoma and 12 had a partial flap loss of > 20% of the flap. In 8 cases the flap was lost and in 10 there was an inadequate venous drainage. In only 1 patient there was an insufficient arterial supply. Looking at the abdominal site, there were 5 patients with an abdominal haematoma, 3 with an abdominal wall herniation. 7 had an impaired abdominal wound healing and 6 developed an abdominal seroma (*Table 4A*).

*Subgroup risk factor analysis**BMI*

Complications requiring surgery occurred in 43 patients in the normal weight group, 79

patients in the overweight group (25 to ≤ 30 kg/m²) and 26 patients in the obese group (30 to ≥ 40 kg/m²). A significant higher ($p < 0.05$) incidence of complications requiring surgery were found in the overweight and obese

Table 4B. Complications differentiated by subgroups

BMI-related (kg/m ²)	Total number of complications (total number of patients)	Percentage	p-value
Underweight (BMI < 18.5)	0 (6)	0%	
Normal weight (BMI 18.5 $\leq$ 25)			
Total number of complications	43 (496)	8.6%	
• Total flap loss	3	0.6%	
• Partial flap loss	3	0.6%	
• Revision	3	0.6%	
• Flap edge necrosis	8	1.6%	
• Fat necrosis	9	1.8%	
• Breast haematoma	9	1.8%	
• Abdominal haematoma	2	0.4%	
• Impaired abdominal wound healing	3	0.6%	
• Seroma	2	0.4%	
• Abdominal wall hernia	1	0.2%	
Overweight (BMI 25 $\leq$ 30)			
Total number of complications	79 (452)	17.5%	<0.05*
• Total flap loss	4	0.9%	
• Partial flap loss	8	1.8%	
• Revision	2	0.4%	
• Flap edge necrosis	19	4.2%	
• Fat necrosis	30	6.6%	
• Breast haematoma	7	1.5%	
• Abdominal haematoma	2	0.4%	
• Impaired abdominal wound healing	2	0.4%	
• Seroma	3	0.6%	
• Abdominal wall hernia	2	0.4%	
Obese (BMI 30 $\geq$ 40)			
Total number of complications	26 (170)	15.3%	<0.05*
• Total flap loss	1	0.6%	
• Partial flap loss	1	0.6%	
• Revision	6	3.5%	<0.05*
• Flap edge necrosis	5	2.9%	
• Fat necrosis	8	4.7%	<0.05*
• Breast haematoma	1	0.6%	
• Abdominal haematoma	1	0.6%	
• Impaired abdominal wound healing	2	1.1%	
• Serom	1	0.6%	
• Abdominal wall hernia	0	0.0%	
Nicotine - related			
	Total number of complications (total number of patients)		
Smokers			
Total number of complications	42 (133)	31.6%	<0.005**
• Total flap loss	4	3.0%	<0.05*
• Partial flap loss	5	3.8%	<0.05*
• Revision	2	1.5%	
• Flap edge necrosis	10	7.5%	<0.05*
• Fat necrosis	13	9.8%	<0.05*
• Breast haematoma	1	0.8%	
• Abdominal haematoma	2	1.5%	
• Impaired abdominal wound healing	3	2.3%	
• Seroma	2	1.5%	
• Abdominal wall hernia	0	0.0%	

Table 4B. Complications differentiated by subgroups (continuation)

BMI-related (kg/m ²)	Total number of complications (total number of patients)	Percentage	p-value
Non-smokers			
Total number of complications	106 (991)	10.7%	
• Total flap loss	4	0.4%	
• Partial flap loss	7	0.7%	
• Revision	9	0.9%	
• Flap edge necrosis	22	2.2%	
• Fat necrosis	34	3.4%	
• Breast haematoma	16	1.6%	
• Abdominal haematoma	3	0.3%	
• Impaired abdominal wound healing	4	0.4%	
• Seroma	4	0.4%	
• Abdominal wall hernia	3	0.3%	
Diabetes mellitus - related	Total number of complications (total number of patients)		>0.05
Diabetes mellitus	2 (5)	40%	
No diabetes mellitus	146 (1119)	13.0%	
Chemotherapy - related	Total number of complications (total number of patients)		>0.05
Chemotherapy	90 (760)	11.8%	
No chemotherapy	58 (364)	15.9%	
Radiotherapy - related	Total number of complications (total number of patients)		>0.05
Radiotherapy	81 (660)	12.3%	
No radiotherapy	67 (464)	14.4%	
Age - related	Total number of complications (total number of patients)		>0.05
Age at surgery < 65 years	135 (1064)	12.7%	
Age at surgery ≥ 65 years	7 (60)	11.7%	

Body-Mass Index. *p<0.05 (significant); **p<0.005 (highly significant)

group than in the patient group with a normal weight. The most common complication was fat necrosis in 30 cases in the overweight study population followed by flap edge necrosis in 19 cases. Similar trend is seen in the group of obese patients, where 8 had a fat necrosis and, 5 a flap edge necrosis and 6 required an acute flap revision for venous insufficiency (*Table 4B*).

Smokers

133 patients reported to be smokers at the time of surgery. In 31.6% (n = 42) of them complications arose that required surgery. The highest number of flap-specific complications with statistical significance (p < 0.05) were to be found in the smokers group with total flap loss (4), partial flap loss (5), flap edge necrosis (10) and fat necrosis (13).

There were no significant differences

between subgroups with regard to rates of complications at the abdominal donor site. At the time of surgery, 991 patients were non-smokers, of whom 106 (10.7%) developed complications requiring surgery, yet none of them was of statistical significance compared to the smokers group.

Diabetes mellitus, chemo- and radiotherapy, age

Patients with diabetes mellitus (n = 5), pre-operative chemotherapy (n = 760) and radiotherapy (n = 660) did not have a statistically significant increase in the risk of developing complications requiring surgery compared to the control group (diabetes mellitus p > 0.05; radiation therapy p > 0.05; chemotherapy p > 0.05). Neither was there a statistically significant difference in the incidence of complications requiring surgery between the group of patients aged ≥ 65 years (n = 60)

at the time of surgery compared to the group of patients aged < 65 years ($n = 1064$) ($p > 0.05$).

945 of 1124 patients (84%) were followed up for 2 years and 745 (78.5%) were followed up for 4 years. Twelve patients died.

Discussion

The rates of a complete flap loss after DIEP flap reconstruction given by the literature vary with rates of up to 5% (13–16). The rate of total flap loss in our study lies at 0.6%, which means 8 flap losses out of a total of 1274 DIEP flap reconstructions performed in our department. Higher flap loss rates can be explained by fewer numbers of flap surgeries performed annually in a department with limited experience of microsurgery. It is stated that complication rates for a given procedure are reduced when the procedure is performed on regular terms using a defined algorithm for the surgery technique, but also pre- and postoperative care (17,18). The high level of microsurgical expertise and the use of a highly standardized surgical approach that has been redefined over the last 10 years may explain the low rate of total flap loss in our department (20). The rate has remained constantly low despite an annual increase in the number of flap procedures performed.

Overall complications were statistically significantly higher in patients with a higher BMI compared to patients with a normal weight. Especially complications regarding the tissue perfusion were most common. Also Momeni et al. reported similar findings, showing that patients with a BMI > 35 had higher rates of postoperative complications following microsurgical breast reconstruction (21). Similar findings were reported by Rao et al. who analyzed retrospectively 352 patients who underwent microsurgical breast reconstruction and had a higher BMI (22). A comparison of subgroups differentiated according to their respective BMI category showed that being overweight (BMI 25 to ≤ 30 kg/m²) or obese (BMI 30 to ≥ 40 kg/m²) was associated with a higher incidence of

flap-specific complications, particularly flap edge and fat necrosis ($p < 0.05$). Timmermanns et al. states in their work that body mass index (BMI), and active smoking are risk factors for donor site wound healing complications after free DIEP flap breast reconstructions. In our study we can confirm this findings especially when it comes to flap-related complications such as flap edge and fat necrosis (23). Thus, when an overweight/ obese patient presents for breast reconstruction, they are asked to loose weight with a target BMI of about 30 kg/m². Additionally they are being informed about their higher risk of complications.

In the literature smoking, next to greater BMI, is one of the most common risk factors to cause postoperative complications in terms of perfusion problems, including necrosis and wound healing disorders (23–25). As in the BMI subgroup analysis, the subgroup analysis of smokers versus non-smokers showed that smokers had a higher incidence of flap-related complications (flap edge and fat necrosis as well as total or partial flap loss), and this difference was statistically significant ($p < 0.05$). This was already shown in an older study carried out in our department (36). Interestingly it can be shown, that patients who have stopped smoking at least 3 weeks preoperatively, show to have a lower complication rate compared to smokers (26). Our patients are instructed to stop smoking for at least 6 weeks prior to surgery.

In the current study, patients who had a preoperative radiation therapy to their affected chest wall did not have a significantly higher risk of intra- and postoperative complications compared to patients who did not have radiation therapy ($p > 0.05$). Our finding is contradictory to the finding in the work of Fosnot et al. who reports that a significantly increased rate of intraoperative vascular complications occurs in smokers. Yet this did not negatively affect final outcomes. This observation was carried out on 1025 free flap procedures for breast reconstruction. However, the occurrence of vascular complications may depend on the time between irradiation and microsurgical reconstruction. Baumann et al.

showed in a prospective study of 296 flap reconstructions, that the of complication rate of microsurgical breast reconstructions is reduced after a latency of 12 months between the microsurgical procedure and the radiotherapy compared to reconstructions carried out within the first 12 months after radiotherapy (27). The risk of vascular complications is particularly high in the period up to 3 months after radiotherapy (28). From our experience we can say that similar risk reduction can be already achieved after 6 months between the final radiotherapy session and reconstruction surgery.

Our study found no significant differences in complication rates occurring in the flap area or the donor site in patients who obtained chemotherapy in comparison who did not obtain chemotherapy. Zweifel-Schlatter et al. (29) analyzed the complication rates and effects of chemotherapy on immediate microvascular breast reconstruction with various flaps and compared the rate to patients who did not have chemotherapy prior the microsurgical reconstruction. They concluded that immediate microvascular breast reconstruction after neoadjuvant chemotherapy does not result in an increased complication rate or delay the start of adjuvant treatment. This is concurred with our findings in the study, even though we have compared secondary microvascular breast reconstructions, this strengthen our observation since in our cases more time has elapsed between the chemotherapy and the reconstruction, giving the organism more time for recovery and thus decrease the risk of complications even more.

There was no significant difference in complication rates occurring in the flap area or the donor site in patients aged more than 65 years at the time of reconstruction compared to the patients younger than 65 years. Studies by Serletti et al. and Malata et al. also showed that higher patient age alone was not an increased risk of complications in free-tissue transfers (30,31).

This finding was also confirmed by a smaller patient cohort evaluated by Gill et

al. and by one of our earlier studies (15,32).

The data of this study show that free DIEP flap surgery is an established procedure for autologous breast reconstruction with a low complication rate. This type of reconstruction is the gold standard procedure used for breast reconstruction in our department especially after unsuccessful implant-based reconstruction and the naturally looking results that age with the patient. Certain patients end up with a breast asymmetry after breast reconstruction of only one breast and therefore need a breast reduction of the healthy contralateral side which is performed 2 – 3 months after the autologous reconstruction once the swelling of the reconstructed breast has disappeared. Nipple-areola complex reconstruction with a skate or star flap may be considered after a period of another 2–3 months to allow the gravity to take effect. Final outcomes are usually very close to the visual appearance of the natural breast (*Figs. 1,2,3*).

Conclusion

Overall, the study shows that the DIEP flap surgery is a well-established method for autologous breast reconstruction with a low complication rate when performed in a standardized setting by an experienced microsurgical team. Yet patient characteristics in terms of risk factors need to be taken into account for result prognosis and satisfactory long-term reconstructive results.

Conflict of Interest

The authors declare no conflicts of interests.

Ethics Approval

All procedures performed were in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments.

Figure 1. (A) 39 years old patient after prophylactic nipple – skin - sparing mastectomy; (B) result 12 months after bilateral reconstruction with a DIEP flap

Figure 2. (A) 44 years old patient after ablatio mammae on her right side; (B) result 24 months after reconstruction of the right breast with the DIEP flap and a reduction mammoplasty on the left side

Figure 3. (A) 51 years old patient after ablatio mammae on both sides with an expander on her right side; (B) result 36 months after bilateral reconstruction with the DIEP flap

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