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ORIGINAL CONTRIBUTIONS

Outcome of Body-Contouring Procedures After Massive Weight Loss

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Abstract

Background With the increased popularity of bariatric surgery, the demand for body-contouring procedures is growing. Associated with these procedures are a number of complications due to different risk factors and patients' characteristics. The aim of this study was to assess the outcome of body-contouring procedures and correlate it to possible risk factors.

Methods The study included a collective of 112 patients who underwent 157 body-contouring procedures. Patients' characteristics, risk factors, and complications have been recorded. Three groups were formed based on the type of surgical procedure to perform correlations of BMI, weight of resected tissue, and length of hospital stay using Spearman's rank test. Correlations between patients' risk factors and complication occurrence were analyzed with Fisher's exact test.

Results The most common procedure patients underwent was the classic abdominoplasty ($n = 53$). A significant correlation was found between preoperative BMI and weight of resected tissue in abdominoplasties (rho = 0.69), Fleur-de-Lis abdominoplasties (rho = 0.64), and body lifts (rho = 0.60). There was a significant correlation between weight of resected tissue and length of hospital stay (rho = 0.53) and preoperative BMI and length of hospital stay (rho = 0.4) as well. There was no significant correlation between patients' comorbidities or smoking status and the postoperative complication rate. The mean weight of resected tissue was higher in patients with than without complications requiring surgical revision.

Conclusions The relevance of risk factors commonly believed to have an influence on postoperative complications should be revised. The weight of resected tissue has an influence on complication.

Keywords Body contouring · Weight loss · Outcome · Risk factors · Complications

Introduction

Obesity has become a worldwide health issue resulting in a big demand of bariatric surgery, which is currently the most effective way to achieve and sustain a significant weight loss. Furthermore, bariatric surgery comes along with a significant decrease of comorbidities and an improvement of quality of life [1, 2]. A downside of this treatment is the resulting excess of skin mainly in the abdominal, inguinal, upper leg, and upper arm regions, causing an esthetic problem, which can lead to social withdrawal, problems with intimacy, and even depression. In addition to the psychosocial problem, the excessive skin folds are a favorable ground for skin irritations and infections. Therefore, patients often feel even worse after losing weight than at the time they were overweight [3].

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For these reasons, a high number of patients seek body-contouring procedures like abdominoplasty, body lift, and upper arm, upper leg, or breast lift [4]. These procedures increase patients' quality of life and minimize the likelihood to regain weight or suffer from the disadvantages associated with excessive skin [5–8]. Plastic surgery, therefore, plays a vital role in the postbariatric treatment of obese patients and is often considered a necessity [9].

Body-contouring surgery is, however, significantly associated with complications like hematoma, seroma, wound dehiscence, infections, and need of blood transfusion [10]. Less frequent complications are skin necrosis, significant asymmetry, venous thromboembolism, lymphedema, and neuropathy [11]. Due to increased experience and improved operating techniques, the complication rate has dropped during the last years but still exceeds 25% in the literature [12, 13]. Previous studies showed a significant correlation between weight stability prior to plastic surgery and the occurrence of complications. A stable weight for at least 3–6 months preoperative resulted in fewer complications [14, 15]. van der Beek et al. also showed that the relatively high complication rate had no influence on patients' satisfaction after body-contouring procedures [14]. There are several studies analyzing factors that could influence the outcome of postbariatric body-contouring procedures such as age, smoking status, comorbidities, amount of weight loss, and operation method. Comorbidities like hypertension or diabetes were named to be significant risk factors for developing complications [12]. Obesity at the time of plastic surgery, bariatric surgery, and massive weight loss were also found to increase the complication rate [14]. A later time of drain removal correlated with a higher probability of infections, and the amount of resected tissue caused an in increase in wound-healing problems [13]. A high age and smoking status were described to have a negative influence on wound healing as well [13]. A weight loss greater than 100 lbs. was also named as a significant risk factor for complications [16].

However, literature lacks studies analyzing a possible relation between the amount of resected tissue and weight loss after bariatric surgery or complication rate. The influence of the amount of resected tissue on the occurrence of complications has not yet been examined thoroughly and with a large patient collective. Bruschi et al. reported the average of resected tissue in brachioplasty and thighplasty [17]. Taylor and Shermak found a poor correlation between the weight of resected tissue and weight loss in a collective of 30 patients who underwent different body-contouring procedures, but not for each procedure specifically [18]. Vico et al. found a statistically significant difference in the resected pannus weight after classic abdominoplasty or lower body lift [19]. de Kerviler et al. and Parvizi et al. found a significant influence of the resected weight on the occurrence of postoperative skin necrosis and wound dehiscence regardless of the weight loss or the specific procedures [13, 20].

The aim of our study was to assess the outcome of postbariatric body-contouring procedures considering the different types of body-contouring surgery and patients' characteristics. Parameters like type of operative procedure, amount of resected tissue, preoperative body mass index (BMI), comorbidities, weight loss, occurrence of complications, and duration of hospital stay were assessed. Furthermore, a correlation between complications and comorbidities as well smoking status was performed.

Patients and Methods

The study was approved by the ethics committee of the University of Tübingen (project number 711/2013BO2).

Patients

A retrospective review of 112 patients who had undertaken 157 body-contouring procedures in the Department of Plastic and Reconstructive Surgery, BG Trauma Center at the University Hospital of Tübingen, Germany, between January 2008 and December 2016 was performed. Most of these patients previously underwent bariatric surgery such as laparoscopic Roux-en-Y gastric bypass surgery or sleeve gastrectomy or had a stomach balloon implanted ($n = 92$). Only few of them lost weight through diet and workout alone ($n = 20$). Patients' age, sex, BMI prior to and after bariatric surgery as well as after each body-contouring procedure, type of bariatric surgery, type of body-contouring procedures, weight of excised tissue during body-contouring procedures, secondary illnesses, and previous operations were recorded from the patients' charts. Major complications that needed revisions like hematoma, seroma, wound dehiscence, skin necrosis, infection, or abscess were documented and categorized based on time of occurrence either during the hospital stay or after discharge. Minor complications such as neuropathy and hypertrophic scars or any complication that required no surgical intervention was not recorded because no objective documentation existed. The number and kind of surgical revisions were also recorded. Moreover, a need of blood transfusion as well as the number of transfused blood bags was documented.

Body-Contouring Procedures

Body-contouring procedures were performed after a period of weight stabilization for at least 6 months. The earliest time point of body contouring was 13 months after bariatric surgery if one was performed. Some patients underwent multiple body-contouring procedures ($n = 33$). Revisions due to major complications were not counted as further body-contouring procedures. All procedures were performed under general anesthesia. The most frequent procedure was the classic

abdominoplasty also known as tummy tuck ($n = 53$). The classic abdominoplasty consisted of removal of the abdominal apron, repositioning of the umbilicus, and if necessary, a correction of a rectus diastasis or ventral hernia [21]. Caudal abdominal dermolipectomy with or without umbilectomy was performed on patients with a large hanging pannus almost always using a suspension-type device ($n = 15$) [22]. A Fleur-de-Lis abdominoplasty was performed in patients with both anterior and lateral truncal excess ($n = 22$). The vertical component of this operation consisted of an inverted V incision to decrease the abdominal girth [23].

Another frequent procedure was the lower body lift, which was performed in patients with circular excess tissue on the anterior, lateral, and dorsal aspect of the lower trunk ($n = 18$). An indication to perform this type of operation was massive weight loss with circular excess tissue consisted mainly of skin and less subcutaneous fat and a BMI of 32 kg/m^2 or less. The original technique was firstly introduced by Lockwood [24] as a lift of the thighs and the buttocks. In our department, either the modified technique including an abdominoplasty and a lateral thigh and a buttock lift [25] or the combined technique [26] including the modified technique with an additional medial thigh lift was performed, depending on the amount of existing excess tissue in the medial thigh region [27]. These techniques were combined with a Fleur-de-Lis abdominal excision if this was necessary and the patient wished so.

Medial thigh lifting was performed for removing lax skin usually located on the upper medial thigh using an L-incision in the groin and in the medial thigh region ($n = 31$) [28, 29]. Upper arm lifting was used to remove excess skin on the inner side of the upper arm using and I- or L-incision depending on the amount of excessive tissue ($n = 12$) [30–32]. Seven medial thigh and three upper arm lifts were combined with liposuction to improve the outcome.

A mastopexy in inverted T technique with a superomedially or inferiorly based flap was performed in patients with severe breast ptosis ($n = 6$) [33].

Statistical Analysis

Patients' characteristics were summarized in mean values for parametric variables and percentage for nonparametric variables. The amount of weight loss was analyzed in an independent two-sample t test for each combination of body-contouring procedures. Risk factors like comorbidities and nicotine abuse were statistically analyzed in contingency tables applying Fisher's exact test. A level of significance was set at $p < 0.05$. Correlations between weight of removed tissue, duration of hospital stay, BMI difference before and after weight loss, and BMI prior to the body-contouring procedure were performed nonparametrically with Spearman's rank correlation test.

Results

Demographic Results

Our sample included 88 female (78.6%) and 24 male (21.4%) patients who underwent 157 body-contouring procedures in our clinic. The average age was 45 years, ranging from 19 to 72 years. Twenty patients lost weight without bariatric surgery, 63 underwent sleeve gastrectomy, 23 had a laparoscopic Roux-en-Y gastric bypass, and one patient had a stomach balloon installed. Three patients underwent both stomach balloon implantation and sleeve gastrectomy later on, while two patients underwent sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass later on. The average time between bariatric and plastic surgery was 37 months (range 13–100 months). The average weight before bariatric surgery was 152.9 kg (range 81–260 kg) with a mean BMI of 53.6 kg/m^2 (range 33.2–79.5 kg/m^2). After bariatric surgery, patients achieved a mean weight loss of 63 kg (range 23–180 kg) resulting in a mean weight of 91.1 kg (range 41–165 kg) and an average BMI of 31.8 kg/m^2 (range 20.3–63.7 kg/m^2) at the time of the first body-contouring procedure (Table 1). In total, 156 body-contouring procedures were performed on 112 patients (Table 2). In total, 33 patients (21.0%)

Table 1 Patients' characteristics

Characteristics		Number of patients
Gender	Female	88 (127 body-contouring procedures)
	Male	24 (30 body-contouring procedures)
Age	Mean	45
	Range	19–72
Bariatric surgery (BS)	SL-G	66
	RY-GB	25
	Stomach balloon	1
	None	20
BMI before BS (kg/m^2)	20–29.9	0
	30–39.9	8
	40–49.9	41
	50–59.9	39
	60–69.9	17
	> 70	7
BMI after BS (kg/m^2)	20–29.9	51
	30–39.9	49
	40–49.9	10
	50–59.9	1
	60–69.9	1
	> 70	0

BMI, body mass index; *SL-G*, sleeve gastrectomy; *RY-GB*, Roux-en-Y gastric bypass

underwent more than one body-contouring procedure. Twenty-four (15.3%) patients underwent two, eight (5.1%) other patients underwent three, and one (0.6%) patient underwent four different body-contouring procedures.

Body-Contouring Procedures of the Trunk

Seventy-five patients underwent abdominoplasty, 53 of them underwent the classic procedure (mean BMI 31.9 kg/m^2) with an average of 3.0 kg excised tissue, while 22 patients underwent a Fleur-de-Lis abdominoplasty (mean BMI 30.5 kg/m^2) with an average of 3.2 kg removed tissue. Fifteen patients underwent caudal abdominal dermolipectomy (mean BMI 42.4 kg/m^2) with an average of 5.4 kg excised tissue. Patients who underwent caudal abdominal dermolipectomy had a statistically significant higher BMI preoperatively ($p = 0.004$) compared to patients that underwent classic or Fleur-de-Lis abdominoplasty. Moreover, the weight of removed tissue was significantly higher in these patients ($p = 0.033$).

Lower body lifts were performed on 18 patients. Twelve patients underwent the classic modified or combined technique (mean BMI 27.1 kg/m^2) with an average of 2.9 kg excised tissue. Six other patients (mean BMI 32.0 kg/m^2) needed an additional Fleur-de-Lis abdominoplasty with an average of 4.2 kg total excised tissue.

Body-Contouring Procedures of the Limbs

Upper thigh lifting was performed on 31 patients (mean BMI 31.9 kg/m^2), seven of whom were combined with liposuction. The excised tissue had a mean weight of 1.4 kg. Twenty-four patients had already undergone at least one previous body-contouring procedure. Two patients had undergone a caudal abdominal dermolipectomy and 16 a classic abdominoplasty. Four of those patients also had undergone bilateral mastopexy. Another five patients had already undergone a body lift, and one also had an upper arm lifting.

Upper arm lifting was performed on 12 patients (mean BMI 29.2 kg/m^2) with a mean of 0.6 kg excised tissue. Five of these patients had previously undergone a lower body lift, while three patients had undergone an abdominoplasty and one had undergone an abdominoplasty, a body lift, and a mastopexy as well as a thigh lift previous to the upper arm lift.

Body-Contouring Procedures of the Breast

Four female patients underwent mastopexy and two male patients underwent mastectomy (mean BMI 30.0 kg/m^2) having an average of 0.8 kg tissue removed.

The weight of resected tissue after all contouring procedures is depicted by boxplots in Fig. 1.

Correlation of BMI, Weight of Resected Tissue, and Length of Hospital Stay

For all kinds of body-contouring procedures listed in Table 2, Spearman's rank correlations were performed between all combinations of the following parameters:

BMI difference before and after weight loss
BMI prior to body contouring
Weight of resected tissue
Length of hospital stay

A significant correlation was found between preoperative BMI and weight of resected tissue for classic abdominoplasties (rho = 0.69), Fleur-de-Lis abdominoplasties (rho = 0.64), and body lifts (rho = 0.60).

Only after classic abdominoplasties, there was a significant correlation between weight of resected tissue and length of hospital stay (rho = 0.53) as well as between preoperative BMI and length of hospital stay (rho = 0.40).

Complications

In total, 22 complications occurred after 157 procedures (14% out of all procedures) in 22 patients, which needed 33 revisions in total. The number of revisions ranged between 1 and 4 (mean 1.5). Considering the procedures separately, the complication rates are summarized in Table 2. The highest complication rate occurred after upper thigh lift (35%) followed by caudal abdominal dermolipectomy (20%). The most common complication was seroma occurring in eight cases (5%), followed by hematoma in seven cases (4%). Complications considering wound healing occurred in four cases (3%), while infections occurred in three cases (2%). The highest complication rate was found after upper thigh lift (32%) followed by the complication rate after upper arm lift (17%). All complications that needed revisions and their occurrence are summarized in Table 3.

Blood transfusion was necessary in 15 cases (10%) with a median of 2 bags of concentrated red cells (range 2 to 8 bags). Three of them were subjected to abdominoplasty (4%), four of them to caudal abdominal dermolipectomy (27%), seven of them to body lift (39%), and one of them to upper thigh lift (3%).

Risk Factors

We defined hypertension, diabetes, lipometabolic disorder, and a BMI greater than 30 kg/m^2 as well as anticoagulant medication and smoking as possible risk factors and analyzed their effects on the need for operative revision. Ten patients who suffered from complications had no relevant chronic diseases at the time of plastic surgery. Among all patients who

Table 2 Distribution of body-contouring procedures including average BMI difference after weight loss, average weight of removed tissue, average length of hospital stay, and number of cases with complications that needed revision(s)

Body-contouring procedure	Number of patients	Average BMI difference after weight loss (kg/m^2)	Average BMI before body-contouring procedure (kg/m^2)	Average weight of removed tissue (kg)	Average length of hospital stay (days)	Number of complications that needed revision(s)
Abdominoplasty with umbilicoplasty	53	20.7	31.8	3.0	7.4	3 (6%)
Fleur-de-Lis abdominoplasty	22	20.1	30.5	3.2	6.6	1 (5%)
Caudal abdominal dermolipectomy	15	18.5	42.4	5.4	7.5	3 (20%)
Body lift	12	22.8	27.1	2.9	7.3	1 (8%)
Body lift with Fleur-de-Lis abdominoplasty	6	29.1	32.0	4.2	8.2	1 (17%)
Upper thigh lift	31	22.5	31.9	1.4	7.2	11 (35%)
Upper arm lift	12	29.5	29.2	0.6	6.4	2 (17%)
Mastopexy	6	23.2	30.0	0.8	5.0	0 (0%)

underwent body-contouring procedures, hypertension was the most common chronic disease occurring in 50 cases (32%). Thirty-five patients (22%) suffered from diabetes and 13 (8%) were diagnosed with a lipometabolic disorder. Eight (5%) patients had coronary heart disease or suffered from cardiac arrhythmia and were treated with an anticoagulant medication permanently. Sixteen patients (14%) were regular smokers at the time of the operation (Table 4).

A possible association between complications and patients' risk factors was analyzed in contingency tables using Fishers' exact test. All factors listed in Table 4 were not significantly correlated with a higher complication rate. Also, a preoperative BMI greater than 35 kg/m^2 ($n = 35$) or greater than 40 kg/m^2 ($n = 15$) did not correlate with a higher complication rate.

Another risk factor may be the weight of resected tissue. Therefore, the mean weight of resected tissue was assessed in the patient groups with complications and without complications for the three main groups of body-contouring procedures. Patients that needed one or more revisions due to complications after body contouring of the trunk (abdominoplasty, body lift, or caudal dermolipectomy) had a mean weight of 5.2 kg of resected tissue ($n = 10$), while patients who underwent the same procedures without any major complications had a mean weight of 3.4 kg tissue resected ($n = 98$). After upper thigh lift, the group of patients needing revisions had a mean weight of 1.4 kg tissue removed ($n = 10$), while patients without major complications had a mean weight of 1.4 kg tissue removed as well ($n = 21$). After upper arm lift, the group of patients in need of revisions had a mean weight of 0.7 kg tissue removed ($n = 2$), while patients without major complications had a mean weight of 0.6 kg tissue removed ($n = 10$). Only in the group of body-contouring procedures of

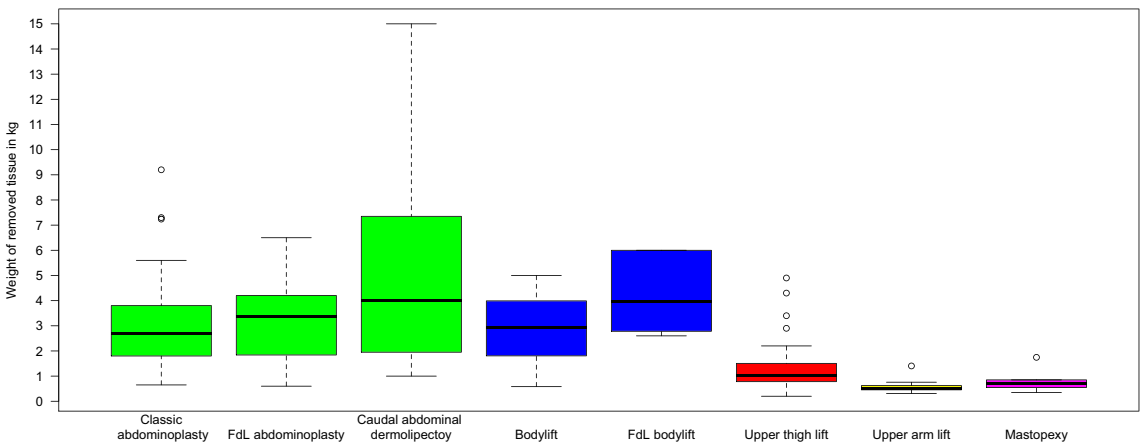

Fig. 1 Boxplots depicting the weight of removed tissue for the different body-contouring procedures with boundaries at the 25th percentile, median, and 75th percentile. Whiskers extended to a maximum distance of 1.5 interquartile ranges. Data beyond these bars were depicted as outliers

Table 3 Incidence of complications that needed revision

Type of complication	Total number	After BC procedure of the trunk	After BC procedure of the upper thighs	After BC procedure of the upper arms
Hematoma	7 (4%)	3 (3%)	3 (10%)	1 (8%)
Seroma	8 (5%)	3 (3%)	5 (16%)	0
Wound-healing impairment	4 (3%)	2 (2%)	2 (6%)	0
Infection	3 (2%)	2 (2%)	0	1 (8%)
Total	22 (14%)	10 (6%)	10 (32%)	2 (17%)

BC, body contouring

the trunk a tendency to significance between the weight of resected tissue and the occurrence of complications could be assessed ($p = 0.09$).

Discussion

Demographic Results

The worldwide growing demand for body-contouring procedures is a result of the growing number of patients who undergo bariatric surgery. To optimize the outcomes of these reconstructive procedures, a proper assessment of patients' demographic characteristics, risk factors, and occurrence of complications is highly important. Most authors reported an average patient age of 39.9 to 47.9 years with a gender distribution between 80 and 95% women and between 5 and 20% men. The BMI before bariatric surgery was usually ranging between 46.8 and 56.7 kg/m^2, while BMI before plastic surgery was usually between 27.8 and 33.8 kg/m^2 [12–14, 34–36]. The patient characteristics of our study population match the observations of these previous studies.

Weight of Resected Tissue and Length of Hospital Stay

A weight of 2.9 to 6.2 kg of resected tissue after abdominoplasty was reported in some previous publications. Neaman et al. reported of a mean amount of 3.96 kg resected tissue in patients with complications and 1.85 kg in patients without complications in their study of 206 patients who underwent classic abdominoplasty [12]. de Kerviler et al. analyzed 104 patients after abdominoplasty and reported of an average of 3.00 kg resected tissue [20]. Iglesias et al. examined 69 patients who underwent abdominal body-contouring procedures with an average of 6.21 kg resected tissue in the study population [35]. However, previous literature lacks a differentiated documentation of weight of removed tissue after other postbariatric procedures than abdominoplasties like body lifts, caudal abdominal dermolipectomy, thigh and upper arm lift, or mastopexy, as we presented in this study.

Moreover, an interesting result of this study was the confirmation of the empirical observation that patients who undergo caudal abdominal dermolipectomy form a group of postbariatric patients that responded the least to bariatric surgery. These patients usually achieve a lower BMI loss and, therefore, have a higher preoperative BMI than patients who undergo abdominoplasty or body lift procedures. The amount of resected tissue is also higher among these patients.

Iglesias et al. reviewing 69 abdominoplasties and Nemerofsky et al. analyzing 200 cases of body lift procedures reported a mean duration of hospital stay of 7 and 3 days, respectively [35, 36]. This is surprising as one would expect that patients had a longer hospital stay after a body lift than after an abdominoplasty, and this is probably due to different insurance systems in different regions. Garcia Botero et al. who studied 153 patients undergoing 198 body-contouring procedures reported a mean length of hospital stay of 2.4 days after extended abdominal lipectomy and 2.3 days after circumferential lipectomy and even shorter after cruro- or brachioplasty (2.0 and 1.9 days, respectively) [10]. In our patient collective, the length of hospital stay depended on the complexity of the body-contouring procedure and was higher than that described by Nemerofsky et al. and Garcia Botero et al. This is mostly due to the fact that the body-contouring procedures performed in our department were sponsored by the health insurance of the patient.

Complication Rate and Risk Factors

Body-contouring procedures come with a wide range of complications like hematoma, seroma, infection, and wound-healing problems. The complications presented in this study were considered major if one or multiple revisions were needed. Our overall complication rate of 14% is comparable with other studies. In the literature, the best investigated complications are those after abdominoplasties. Vastine et al. reported a complication rate of 13% [37] and Parvizi et al. described a complication rate of 10.2% [13]. Our results were better considering the complication rates of 6% after classic and 5% after Fleur-de-Lis abdominoplasty. On the other hand, the mostly still obese and multimorbid patients who had undergone caudal abdominal dermolipectomy had a higher complication rate of 20%. The overall complication rate after body lift of 11% (two out of 18 patients) was also concordant to previous studies. However, data comparison should be viewed cautiously because of the different definitions of major and minor complications. Interestingly, the complication rates after upper arm or upper thigh lift were 17 and 32%, respectively, in our patient population and, therefore, obviously higher than after other body-contouring procedures. This is mostly due to the anatomical and functional exposition of the limbs

Table 4 Incidence of risk factors in cases with or without complications

Risk factors	Cases with complications	Cases without complications
Hypertension	7	43
Diabetes mellitus	5	30
Lipometabolic disorder	2	11
BMI > 30 kg/m^2	12	75
Permanent anticoagulant medication*	2	6
Nicotine	3	13

*Patients with permanent anticoagulant medication needed a higher dose of heparin during hospital stay

that makes them more susceptible to complications. Gusenoff et al. even found complication rates of 49–74% after thigh lift, depending on the type of surgery that was performed. However, it has to be mentioned that these rates included minor and major complications [38].

Another interesting aspect found in the literature is that some authors found higher complication rates after bariatric surgery than after weight loss through diet and exercise. This was due to the greater amount of resected tissue and nutritional deficiencies after bariatric surgery [39], while other authors did not find an association between the type of weight loss and postoperative complications [40]. In our dataset, two out of 25 patients without bariatric surgery (8%) and 20 out of 111 patients with bariatric surgery (15%) had major complications. Although this difference was not statistically significant, a tendency for more complications in patients after bariatric surgery could be observed.

Blood transfusion was necessary in more than one third of patients who had undergone lower body lifts and in more than one fourth of patients who had undergone caudal abdominal dermolipectomy in this study. These rates exceeded the rates of other studies [41, 42] and were observed less and less in the last 2 years of the study. More precisely, only two patients needed a blood transfusion in 2005 and none of the patients in 2006. This is due to a gain in experience among surgeons [43] that leads us to reevaluate the indication criteria for performing lower body lifts. Lower body lifts are now mainly recommended in patients that reduced their weight massively (BMI < 30 kg/m^2), having only a minimal amount of subcutaneous fat tissue and suffering from excessive circular skin folds [41]. A lipo-body lift with minimal liposuction to facilitate undermining and, therefore, minimize blood loss is preferred in these cases [44]. For more obese patients, a two-stage procedure with an abdominoplasty first and a buttock lift later on is recommended. Patients who need caudal abdominal dermolipectomy were in all cases severely obese and multimorbid at the time of operation, having a high complication rate including the need for blood transfusion. A precise preoperative preparation including an increase of hemoglobin with iron administration is mandatory for these patients. Moreover, meticulous care should be given to avoid operative hypothermia and, hence, minimize the risk of blood loss [45, 46].

BMI

Neaman and Hansen considered a BMI higher than 30 kg/m^2 at the time of the body-contouring procedure to be a risk factor [12]. Vastine et al. reviewed 90 patients after having an abdominoplasty dividing them into nonobese, borderline obese, and obese groups. They found a significantly higher complication rate of 80% among obese patients [37]. van der Beek et al. reported a correlation between the occurrence of complications and the preoperative BMI after 43 postbariatric body-contouring procedures as well [14]. In a large database analysis of 1797 patients, Fischer et al. did not find a higher complication rate and postoperative morbidity in patients who were still obese [47]. The opposite was found in the studies performed by Coon et al. and Nemerofsky et al. who examined 449 and 200 patients, respectively, but could not find a correlation between preoperative BMI and complication rate [34, 36]. Shermak et al. who examined 139 patients after body-contouring surgery came to similar results as well [48]. Using Fisher' exact test, we could also not find a higher occurrence of complications in patients with a high BMI (more than 30, 35, or 40 kg/m^2) in our patients.

Weight of Resected Tissue

Vastine et al. reported that the mean amount of resected tissue in patients with complications was significantly higher (3.96 kg) than in patients who did not develop complications (1.85 kg) [37]. Parvizi et al. came to a similar result when reviewing 205 patients after abdominal dermolipectomy. The probability for wound-healing problems was significantly higher for those patients who had more than 4.00 kg of tissue removed or were obese with a BMI > 35 kg/m^2 [13]. Garcia Botero et al. found an even higher complication rate after resecting 2.70 kg of excess tissue [10]. These results are concordant with our observations. In all three groups of body-contouring procedures of the trunk, upper arms, or upper thighs, the weight of resected tissue was higher in the subgroups of patients with complications who needed surgical revision than in the subgroups without such complications.

Comorbidities

Neaman and Hansen reviewed the outcome and risk factors of 206 abdominoplasty cases performing a correlation between diabetes and hypertension and the occurrence of complications. They found that diabetic patients had an increased risk of developing complications when compared to nondiabetics (62.5 versus 35.3%). Hypertensive patients showed a higher complication rate of 57% as well [12]. Parvizi et al. found an increased risk of developing seromas in diabetics between 20 and 40 years, while patients with hypertension showed to be more prone to developing hematoma [13]. Fischer et al. found a higher risk of postoperative minor and major complications in patients with either diabetes, hypertension, bleeding disorder, cardiac comorbidities, poor nutritional status, or a combination of the abovementioned comorbidities [47]. The evaluation of our data showed that none of these comorbidities was significantly correlated with an increased occurrence of complications. This is similar to the findings of Shermak et al. who examined 139 patients after body-contouring surgery and argued that hypertension, diabetes, and cardiac diseases do not pose as risks for postoperative complications [48].

Smoking Status

Neaman and Hansen described a correlation between smoking and minor complications including hematoma or seroma requiring no intervention, epidermolysis, small wound dehiscence, neuropathic pain, and minor cellulitis [12]. Manassa et al. also showed statistical difference between smokers and nonsmokers in their study of 132 patients receiving an abdominoplasty. Smokers had a rate of 47.9% when it came to wound-healing problems and wound dehiscence versus nonsmokers with a rate of 14.8% [49]. In our patient population, smoking status did not correlate with the occurrence of major complications and was accordant to de Kerviler et al. [20], Shermak et al. [48], and Chaouat et al. who analyzed 258 patients after abdominal dermolipectomy [50].

Conclusions

A differentiated documentation and analysis of BMI, weight of resected tissue, length of hospital stay, risk factors, and complications for the usual postbariatric body-contouring procedures were performed. A relatively good correlation between BMI before classic abdominoplasty, Fleur-de-Lis abdominoplasty, and body lift and the amount of resected tissue was found ($rho = 0.69$, $rho = 0.64$, $rho = 0.60$). Previously described risk factors such as preoperative BMI, nicotine abuse, and comorbidities like hypertension, diabetes, lipometabolic disorder, or permanent anticoagulant medication did not correlate with a higher complication rate. The mean weight of resected tissue was, however, higher in patients with than without complications needing surgical revision, especially in patients with body-contouring procedures of the trunk.

Compliance with Ethical Standards

The study was approved by the ethics committee of the University of Tübingen (project number 711/2013BO2).

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Statement This does not apply to the study. No identifying information is available in the article.

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