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ARTICLE

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Is there any difference in perioperative characteristics or postoperative complications between overweight, normal-weight and obese patients in delayed DIEP reconstructions?

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ABSTRACT

Increased number of overweight and obese women are seeking breast reconstruction. Studies have demonstrated that obese experience increased rates of complications, but less data is available considering overweight patients. We analyzed the impact of body mass index (BMI) on perioperative characteristics and complications in unilateral delayed deep inferior epigastric perforator flap (DIEP) reconstructions. The records of patients with DIEP reconstruction performed between 2014 and 2020, were retrospectively analyzed. Patients were categorized into obese (BMI $\geq$30), overweight (BMI 25.0–29.9), and normal-weight groups (BMI $<$25). Patient characteristics (age, comorbidity, radiation, abdominal surgery, ASA category, and smoking), perioperative characteristics (length of operation, blood loss, vasoactive drugs, fluid administration, and urine output), and postoperative complications were recorded. The study included 308 patients. Of these, 104 (34%) were normal-weighted, 142 (46%) overweight and 62 (20%) obese. Among patients with BMI $\geq$ 25, blood loss increased ($p = 0.002$) and the length of operation tended to be longer ($p = 0.072$). No between-groups difference existed in fluid administration ($p = 0.319$), urine output ($p = 0.425$), or use of vasoactive drugs ($p = 0.815$). There was no statistically significant difference in overall complications ($p = 0.122$) between BMI groups. Blood loss $>$150ml was associated with both minor and major complications ($p = 0.022$). Greater BMI moderated with the radiation therapy for higher risk of minor complications (OR 42.0, 95%CI 3.54–49.7, $p = 0.003$). We conclude that greater BMI alone is not associated with a higher overall complication rate, but both overweight and obesity may be moderators for other risk factors.

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Introduction

Obesity, defined as having a body mass index of $\geq$30 kg/m^2 [1], is a significant public health concern [2]. Individuals with a BMI of 25.0–29.9 are considered overweight [3]. All overweight and obese are at risk for developing associated morbidities or diseases such as hypertension, high blood cholesterol, type 2 diabetes, coronary heart disease [3], and a multitude of health conditions, including breast cancer [2,4,5]. There is an increased likelihood that a patient seeking breast reconstruction is overweight or obese than normal-weight [4,5].

Deep inferior epigastric perforator (DIEP) flap has become the most popular option for autologous breast reconstruction [6]. Some surgeons consider obesity to be a relative contraindication for abdominal-based reconstruction [2]. However, overweight and obese women have been reported to benefit from DIEP flap reconstruction in a fashion similar to patients with normal weight [2,4,7] although especially obese experience increased rates of surgical complications, donor site complications, and flap failures [5,8–12]. Most of the breast reconstruction studies compare obese patients to non-obese and do not distinguish between normal-weight and overweight patients. Less data is available on the impact of overweight on complications in DIEP reconstructions. It has been reported in general and cardiac surgery that paradoxically overweight and moderately obese patients undergoing surgery have a lower risk when compared to patients with normal weight [13].

Prior studies evaluating the impact of BMI on breast reconstruction usually include immediate, delayed, unilateral, and bilateral operations [5,10–12,14–16]. A direct comparison of these different operations may be misleading because immediate and bilateral operations include several operations. The complication rate has been reported to be higher after immediate reconstruction than delayed reconstruction [17]. Complication rates reported for immediate procedures describe outcomes for two operations, while complications in delayed reconstruction are attributable only to the reconstructive procedure.

This study seeks to compare patient and perioperative characteristics and postoperative complications between normal-weight, overweight and obese patients in unilateral delayed DIEP reconstructions.

Patients and methods

This retrospective study was conducted using data from the Tampere university hospital (Finland) breast reconstruction

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database. We identified all performed delayed, unilateral DIEP flap breast reconstruction operations between 1 January 2014 and 31 December 2020. Permission to access the clinical records of the patients for the study was obtained from the scientific center of Tampere University Hospital. The study was reported according to STROBE guidelines. By reviewing the clinical records, we ensured that there were no duplicates.

We included only unilateral, delayed reconstructions because we wanted to make the comparison between BMI groups without confounding factors like bilateral operation, simultaneous symmetrization procedure, or immediate reconstruction with mastectomy. We collected data on patient characteristics, perioperative care details, and postoperative complications. Patient characteristics included age, body mass index (BMI), smoking status, comorbidities, antihypertensive drugs used, ASA (American Society of Anesthesiologists) category, radiation therapy, and prior surgery/scars in the abdominal area. Patients were categorized into groups by BMI, as follows: normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese ($\geq$30 kg/m^2). Smoking status was dichotomized as "smoker" or "non-smoker". Comorbidities were divided into diabetes, cardiovascular disease, asthma/COPD (chronic obstructive pulmonary disease), and others. Antihypertensive drugs used included angiotensin receptor blockers, calcium-channel blockers, beta-blockers, and diuretics. Radiation therapy included radiotherapy after a primary breast cancer operation. Perioperative care-related variables included the length of operation, estimated blood loss, administration of vasoactive drugs (including phenylephrine, dobutamine, norepinephrine), total fluid administration (first 24 h), and total urine output (first 24 h). Postoperative complications identified within 30 days of operation were graded with Clavien–Dindo classification. Minor complications included (1) seroma or other minor deviation (e.g. wound healing problem) from a normal postoperative course without the need for pharmacological treatment or surgical interventions and (2) infection or wound healing problem without surgical intervention but requiring per oral pharmacological treatment (antibiotics). Major complications included (1) deep infection, (2) hematoma, (3) skin or fat necrosis or wound problem requiring surgical intervention in the operation theatre, and (4) life-threatening complications (e.g. pulmonary embolism). The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Statistics

Differences between groups were analyzed using Fisher's exact test or Mann–Whitney test. Multivariable multinomial logistic regression analyses were applied to estimate odds ratios (ORs) and 95% confidence intervals (CIs) to analyze the association between possible risk factors for complications. The factors included in the model were age, BMI, ASA, blood loss, cardiovascular disease, diabetes, fluids, reconstruction time, urine output, antihypertensive drugs, and radiation therapy. In the forward stepwise model, also all interactions with BMI, and statistically significant interactions between all other factors were included. As univariable statistically significant factors age, BMI, blood loss, fluids, urine output, radiation therapy, and antihypertensive drugs were forced into the model, but other factors and their interactions were included in the final model only if they were statistically significant. A p-value < 0.05 was considered statistically significant. All analyses were conducted with IBM SPSS statistics version 26, Armonk NY: IBM Corp. Released 2019.

Results

Patient characteristics according to BMI are presented in Table 1 and perioperative characteristics in Table 2. A total of 308 patients with unilateral delayed DIEP were included. Of comorbidities, overweight and obese patients had more commonly cardiovascular disease ($p = 0.012$) as well as antihypertensive medication ($p < 0.001$) than normal-weighted patients. The same was observed with diabetes, but the number of patients was so small ($n = 9$) that we did not take it to further analyses. No statistically significant between-groups differences existed in the history of radiation therapy ($p = 0.072$), ASA category ($p = 0.075$), median age ($p = 0.911$), smoking status ($p = 0.454$), or prior abdominal surgery ($p = 0.636$).

Some differences were observed between groups in the perioperative course. The median reconstruction time tended to be longer in overweight (median 300 min) and obese (median 320 min) patients compared to normal weight (median 284 min)

Table 1. Patient characteristics according to body mass index ($N = 308$).

	BMI < 25.0 ($n = 104$)		BMI 25.0–29.9 ($n = 142$)		BMI ≥ 30.0 ($n = 62$)		p-value
Age, years, Median (Md), Interquartile Range, Range)	53.5	(48–61; 27–71)	54	(47–60; 18–72)	52	(49–59; 35–72)	0.911
Age ≥ 60 years, *n* (%)	29	(28)	39	(27)	10	(16)	0.168
ASA category, *n* (%)							0.075
1	25	(24)	37	(26)	13	(21)	
2	77	(74)	95	(67)	41	(66)	
3	2	(2)	10	(7)	8	(13)	
Smokers, *n* (%)	5	(5)	13	(9)	5	(8)	0.454
Antihypertensive drugs, *n* (%)							0.001
None	89	(86)	100	(70)	38	(61)	
Yes	15	(14)	42	(30)	24	(39)	
Radiation therapy, *n* (%)	44	(42)	81	(57)	30	(48)	0.072
Cardiovascular disease, *n* (%)	11	(11)	25	(18)	18	(29)	0.012
Diabetes mellitus, *n* (%)	0	(0)	5	(3)	4	(6)	0.026
Asthma, *n* (%)	24	(23)	32	(22)	15	(24)	0.984
Other diseases, *n* (%)	10	(10)	16	(11)	7	(11)	0.914
Prior abdominal surgery, *n* (%)							0.636
Yes	27	(26)	33	(23)	12	(19)	
No	77	(74)	109	(77)	50	(81)	

Differences between Body Mass Index groups were tested using Fisher's exact test. ASA category: American Society of Anesthesiologists category. Antihypertensive drugs included angiotensin receptor blockers, calcium-channel blockers, beta-blockers, and diuretics.

Table 2. Perioperative characteristics according to body mass index ($N = 308$).

	BMI < 25.0 ($n = 104$)		BMI 25.0–29.9 ($n = 142$)		BMI ≥ 30.0 ($n = 62$)		p-value
Reconstruction time, Median (InterQuartileRange, Range)	284	(240–341; 136–570)	300	(249–340; 124–583)	320	(253–377; 122–560)	0.072
Reconstruction time > 340 min, *n* (%)	26	(25)	34	(24)	27	(44)	0.013
Hospital stay days, Md (IQR, Range)	5	(4–5; 3–6)	5	(4–5; 3–7)	5	(4–5; 4–9)	0.129
Estimated blood loss, Md (IQR, Range)	80	(50–120; 20–240)	92.5	(62–141; 20–500)	120	(60–203; 30–900)	0.002
Blood loss > 150 ml, *n* (%)	12	(11)	28	(20)	25	(40)	<0.001
Total fluids (ml), Md (IQR, Range)	4210	(3282–5204; 2018–6720)	3821	(3216–4732; 1210–7120)	4052	(3207–5063; 1763–6677)	0.319
Total fluids < 3200 ml, *n* (%)	24	(23)	34	(24)	14	(23)	1.000
Total urine output (ml), Md (IQR, Range)	2203	(1632–2742; 506–4405)	2041	(1521–2564; 557–4910)	2055	(1695–2556; 875–4050)	0.425
Urine output < 1600 ml, *n* (%)	25	(24)	39	(27)	11	(18)	0.337
Vasoactive drug used, *n* (%)							0.815
None	35	(34)	52	(37)	20	(32)	
Yes	69	(66)	90	(63)	42	(68)	

Differences between Body Mass Index groups were tested using Fisher's exact test. ASA category: American Society of Anesthesiologists category. Vasoactive drugs used include phenylephrine, dobutamine, and noradrenalin.

Table 3. Detailed comparison of complications between BMI groups ($N = 308$).

	All groups ($N = 308$) n (%)	BMI < 25 ($n = 104$)		BMI 25–29.9 ($n = 142$)		BMI ≥ 30 ($n = 62$)		p-value
		n	(%)	n	(%)	n	(%)	
All complications								0.122
None	205 (67)	75	(72)	96	(68)	34	(55)	
Minor complications	51 (17)	13	(12)	21	(15)	17	(27)	
Major complications	52 (17)	16	(15)	25	(18)	11	(18)	
Minor complications*								0.968
Seroma or minor wound problem treated without antibiotics	21 (41)	7	(41)	9	(43)	5	(38)	
Wound problem requiring antibiotics	30 (59)	10	(59)	12	(57)	8	(62)	
Major complications								0.494
Hematoma	11 (21)	3	(19)	7	(28)	1	(9)	
Necrosis or wound problem requiring re-operation	19 (36)	6	(37)	7	(28)	6	(55)	
Deep infection	5 (10)	0		3	(12)	2	(18)	
Pulmonary embolism	5 (10)	3	(19)	2	(8)	0		
Re-anastomosis	12 (23)	4	(25)	6	(24)	2	(18)	

Differences between Body Mass Index groups were tested using Fisher's exact test. * Of all complications, six occurred in the donor site (two in the overweight and four in the obese group). These complications were minor (three wound problems treated without antibiotics and three required per oral antibiotics). All other complications occurred in the reconstructed breast area.

patients but did not reach statistical significance with $p = 0.072$. There was a significantly higher rate of patients with operation time >340 min in the obese patients' group ($p = 0.013$). Estimated blood loss was greater in obese (median 120 ml) and overweight (median 92.5 ml) than normal weight (median 80 ml) patients ($p = 0.002$). The rate of patients who had estimated blood loss over 150 ml was significantly higher in overweight and obese patients' groups ($p < 0.001$). There was no statistically significant difference between groups in intraoperative vasopressor use ($p = 0.815$), administered fluids ($p = 0.319$), or urine output ($p = 0.425$). Five of our patients (1.6%) received a blood transfusion.

A detailed comparison of complications between BMI groups is presented in Table 3. There was no statistically significant difference in major or minor complications between groups ($p = 0.122$). There were no total flap failures in our study. Of all complications, six occurred in the donor site (two in the overweight and four in the obese group). These complications were minor (three wound problems treated without antibiotics and three required per oral antibiotics) No surgical intervention was required. All other complications occurred in the reconstructed breast area. The median length of postoperative hospital stays (5 days) did not differ between groups.

Patient and perioperative characteristics according to complications are presented in Table 4. Only blood loss >150 ml was associated with complications ($p = 0.022$).

We performed multivariable multinomial logistic regression analysis to predict complications according to patient and perioperative characteristics (Table 5.). Obesity predicted minor complications (OR 2.59; 95% CI 1.07–6.23, $p = 0.034$) in the multivariable-adjusted model without interactions. An interaction between BMI and radiation therapy turned to be the only statistically significant risk combination for minor complications (OR 42.0, 95%CI 3.54–49.7, $p = 0.003$). Major complications were increased among patients under 60 years of age and among those patients with blood loss over 150 ml without any statistically significant effect on BMI.

Discussion

Our data yielded important insights into the effects of BMI on delayed unilateral DIEP reconstruction. In our study, the number of overweight and obese patients exceeded the number of normal-weight patients, which agrees with prior studies [4,5]. It has been established that high BMI increases the risk for surgical complications and overall morbidity in breast

Table 4. Patient and perioperative characteristics according to complications ($N = 308$).

	None ($n = 205$)		Minor ($n = 51$)		Major ($n = 52$)		
	n	(%)	*n*	(%)	*n*	(%)	*p*
Age ≥ 60 years	59	(29)	12	(23)	7	(13)	0.068
ASA category							0.861
1	49	(24)	11	(22)	15	(29)	
2	142	(69)	36	(71)	35	(67)	
3	14	(7)	4	(8)	2	(4)	
Smokers	17	(8)	3	(6)	3	(6)	0.850
Radiation therapy	106	(52)	24	(47)	25	(48)	0.798
Cardiovascular disease	36	(18)	10	(20)	8	(15)	0.834
Asthma	46	(22)	16	(31)	9	(17)	0.235
Other diseases	19	(9)	6	(12)	8	(15)	0.359
Antihypertensive drugs	48	(23)	17	(33)	16	(31)	0.232
Body mass index							0.122
<25	75	(37)	13	(25)	16	(31)	
25–29	96	(47)	21	(41)	25	(48)	
≥30	34	(17)	17	(33)	11	(21)	
Reconstruction time > 340 min, *n* (%)	54	(26)	15	(29)	18	(35)	0.477
Bleeding > 150ml	35	(17)	12	(23)	18	(35)	0.022
Total fluids < 3200 ml	53	(26)	6	(12)	13	(25)	0.089
Urine output < 1600 ml	53	(26)	7	(14)	15	(29)	0.129
Vasoactive drug used							0.579
None	75	(37)	17	(33)	15	(29)	
Yes	130	(63)	34	(67)	37	(71)	

Differences between complication groups were tested using Fisher's exact test. ASA category: American Society of Anesthesiologists category. Antihypertensive drugs included angiotensin receptor blockers, calcium-channel blockers, beta-blockers, and diuretics. Vasoactive drugs used include phenylephrine, dobutamine, and noradrenalin.

Table 5. Association of patient and perioperative characteristics on complications.

		Multivariable multinomial logistic regression									
	No complications ($n = 205$)	Minor complications ($n = 51$)					Major complications ($n = 52$)				
		Without interactions		With interactions			Without interactions		With interactions		
	%	OR	(95% CI)	OR	(95% CI)	%	OR	(95% CI)	OR	(95% CI)	%
Age											
≥ 60 years	98.7	0.84	(0.40–1.79)	0.67	(0.30–1.48)	1.3	0.38	(0.15–0.91)	0.32	(0.13–0.80)	0
<60years	94.3	1,00		1.00		3.0	1.00		1.00		2.6
Body mass index											
≥30	85.5	2.59	(1.07–6.23)	0.76	(0.20–2.81)	12.9	1.02	(0.40–2.58)	0.54	(0.12–2.47)	1.6
25–29	97.2	1.27	(0.58–2.77)	1.31	(0.43–3.99)	0	1.09	(0.53–2.27)	1.58	(0.49–5.12)	2.8
<25	99.0	1.00		1.00		0	1.00		1.00		1.0
Radiation therapy											
Yes	94.2	0.69	(0.36–1.32)	0.08	(0.01–0.66)	5.2	0.82	(0.43–1.56)	0.58	(0.17–1.92)	0.6
No	96.7	1.00		1.00		0	1.00		1.00		3.3
Blood loss											
>150 ml	81.5	1.06	(0.46–2.44)	1.01	(0.41–2.48)	9.2	2.30	(1.09–4.82)	2.22	(1.03–4.78)	9.2
≤150 ml	99.2	1.00		1.00		0.8	1.00		1.00		0
Total fluids											
<3200	98.6	0.45	(0.15–1.30)	0.40	(0.12–1.27)	0	0.91	(0.37–2.22)	0.91	(0.36–2.27)	1.4
≥3200	94.5	1.00		1.00		3.4	1.00		1.00		2.1
Total urine output											
< 1600 ml	96.0	0.69	(0.25–1.91)	2.30	(0.50–10.5)	1.3	1.21	(0.51–2.88)	2.68	(0.71–10.1)	2.7
>1600 ml	95.3	1.00		1.00		3.0	1.00		1.00		1.7
Antihypertensive drugs											
Yes	85.2	1.50	(0.71–3.15)	1.09	(0.54–2.22)	9.9	1.36	(0.64–2.89)	1.36	(0.63–2.94)	4.9
None	99.1	1.00		1.00		0			1.00		0.9
BMI ≥ 30*Radiation therapy	70.0			42.0	(3.54–497)	26.7			4.52	(0.67–30.7)	3.3
BMI25–29*Radiation therapy	100.0			8.75	(0.84–91.5)	0			1.23	(0.27–5.67)	0
BMI < 25*No radiation therapy	100.0			1.00		0			1.00		0

Univariable statistically significant variables forced to the model: age, Body Mass Index, blood loss, fluids, urine output, antihypertensive drugs, and radiation therapy. Also included in the model are: American Society of Anesthesiologists category (ASA), cardiovascular diseases, and reconstruction time. Interactions of BMI were modeled forward stepwise and results only for statistically significant ($p < 0.05$) interactions were shown in the table. Antihypertensive drugs included angiotensin receptor blockers, calcium-channel blockers, beta-blockers, and diuretics. Multivariable multinomial logistic regression analysis was used to predict complications. Reference for minor and major complications was no complications. Results were shown using odds ratios (OR) with 95% confidence intervals (CI) and predicted percentages of the observations in the subgroups (%).

reconstructions [8,10,12,14,18,19]. We found that overweight or obesity was not associated with a statistically significant increase in the overall complication rate. In prior reports, the strongest independent risk factor for complications in autologous breast reconstruction was BMI> 35 [20] and a significantly higher rate of major complications have been reported

to occur in patients with BMI> 40 [14]. In our study, the median BMI in the obese group was 31.5, which is lower than in prior studies.

A high BMI and a history of radiotherapy have been recognized as separate independent risk factors for postoperative complications [18]. In this study, neither radiation therapy nor greater BMI alone was associated with a higher complication rate. In the interaction model, obesity was found to moderate the effect of radiation therapy for minor complications.

Of all complications, six occurred in the donor site (two in the overweight and four in the obese group). All other complications occurred in the reconstructed breast area. Obese patients did not have a significant difference in donor-site morbidity compared to overweight or normal weight patients, which is in the same line with prior studies [16]. The aim of this study was to compare complications within 30 days after the operation. We were not able to evaluate long-term complications like abdominal wall bulging or hernia.

In prior studies with abdominally-based flaps, both immediate, delayed and bi- and unilateral reconstructions have been compared [5,11,12,15,16]. In our study, we studied only delayed unilateral reconstruction because we wanted to make the comparison between BMI groups without confounding factors like bilateral operation, simultaneous symmetrization procedure, or immediate reconstruction with mastectomy, which may have an influence on results.

In our study, blood loss >150 ml was associated with a higher complication rate, which is supported by prior publications [21]. A volume of blood loss and a need for blood transfusion has been shown to increase morbidity and length of hospital stay [20]. In this study, intraoperative blood loss increased with greater BMI. The rate for blood transfusion (1.6%) was comparable with prior studies' transfusion rate from 1.6% to 8.2% in autologous breast reconstructions [20,22]. The median length of postoperative hospital stays (5 days) did not differ between groups. The length of stay in the obese population has been reported to vary from 4.2 to 7 days [8,14], which is comparable with our study.

Our operation time was in line with the prior study, where the mean operation time was 289 min [23]. The length of operation tended to be longer both in overweight and obese patients, which also agrees with earlier reports [14,23]. The duration of surgery has been reported to be an independent risk factor for postoperative complications [21], which was not supported by our study.

The development of postoperative complications is a multifactorial phenomenon. Studies have reported that hypertension and the administration of antihypertensive drugs are significant risk factors for postoperative complications, especially wound complications [10]. In this study, overweight and obesity were more commonly associated with cardiovascular disease. There was a significant difference in the use of antihypertensive medication when compared overweight and obese patients to normal weight, but antihypertensive medication did not have a statistically significant impact on minor or major complications.

The principle of avoiding perioperative hypotension is the main focus in microvascular patients because it may increase the risk of thrombotic events. It has been found that both aggressive fluid delivery [24] and fluid under-resuscitation may lead to complications [19]. The administration of vasopressors has been commonly avoided because of the theoretical concern of inducing vasospasm, thrombosis, or congestion in the vessels of the anastomosis [25]. Studies have suggested the opposite results, vasopressor administration may even improve outcomes [25]. In our study, fluid administration, urine output, or use of vasoactive drugs did not differ between groups or were not significantly associated with complications.

This study is not without limitations. The retrospective design is less accurate than if collected prospectively. Also, our analysis includes complications 30 days after the operation, which does not capture long-term complications. The lack of extensive subject numbers in a single-center site limits the power of the study. The study was not randomized.

Conclusion

Although we found no statistically significant difference in overall complications between BMI groups, greater BMI was associated with characteristics, which increased complication rate as a co-effect with other risk factors. Blood loss was greater and operation time tended to be longer in patients with BMI $\geq$ 25. Also, greater BMI combined with radiotherapy and blood loss > 150 ml was associated with a higher complication rate. It might be advisable to consider weight loss both in overweight and obese patients before delayed reconstruction as an option to minimize the risk of complications and achieve optimal results.

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