Evaluation of clinical outcomes of deep inferior epigastric artery perforator flap breast reconstruction and number of flap perforators

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Background
Perforator flaps have revolutionized reconstructive surgery over the past decades specifically breast reconstruction. Deep inferior epigastric perforator (DIEP) flap is considered the workhorse perforator free flap for breast reconstruction worldwide. There has always been a debate regarding the adequate number of harvested perforators to minimize flap and donor-site complications.
The aim of this study was to evaluate the effect of number of perforators harvested on the overall DIEP flap survival and flap-related complications in addition to donor-site complications.
Patients and methods
A prospective review was performed on all DIEP flaps performed over 18 months. The flaps were subdivided based on the number of perforators used in each flap and outcomes evaluated regarding flap survival, flap-related complications, and donor-site complications.
Results
A total of 63 patients underwent 72 DIEP flaps. No significant differences were noted in the flap complication rate or the abdominal complications across perforator groups. However, the subgroup analysis showed slight increased rates of fat necrosis among single and double perforators when compared with triple perforators, but it did not reach statistical significance.
Conclusions
The number of DIEP flap perforators does not significantly affect the flap loss rates or abdominal complications rates. However, the rate of fat necrosis may be higher in single-perforator DIEP flaps, suggesting that multiple perforators when feasible to be done with minimal muscle damage may lead to better flap perfusion.

Keywords:
breast reconstruction, deep inferior epigastric perforator flap, perforators

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Introduction

The surge of perforator flaps has been closely related to developing knowledge of the blood supply to the skin. A perforator flap is a piece of skin and subcutaneous tissue supplied by perforator vessels. Perforators pass from their source vessel through either muscle or septum to supply the overlying skin [1].

Perforator flaps offers multiple merits in the form of decreased donor-site morbidity with preservation of underlying musculature which results in subsequent decrease in postoperative pain and analgesic requirements and faster convalescence. In addition, perforator flaps are easier to shape to the defect when compared with musculocutaneous flaps, which are usually bulky and undergo atrophy unpredictably when denervated. The cons of these flaps are tedious dissection, which has a steep learning curve plus longer operative time [1].

The deep inferior epigastric perforator (DIEP) flap arose as a refinement of the traditional transverse rectus abdominus myocutaneous (TRAM) flap to decrease abdominal donor-site morbidity by minimizing fascia and muscles included in the flap.

In 1989, Koshima and Soeda [2] published the first clinical application of the inferior epigastric artery perforator flap when they introduced a couple of cases in which they dissected the perforator vessels of the deep inferior epigastric vessels supplying the lower abdominal tissue through the rectus sheath showing that it was possible to harvest the same amount of tissue as in the TRAM flap without sacrificing the rectus abdominis muscle [2].

In 1994, Allen and Treece [3] described using the DIEP flap for the first time in breast reconstruction when he presented 15 cases of successful breast reconstruction using the same design as in TRAM flap. Many publications in the following years established the role of DIEP to the extent that it has been the standard tool of breast reconstruction in many centers.

As the number of perforators included in DIEP flap is less than those in pedicled or free TRAM, there was a debate among authors regarding the effect of the number of perforators on flap-related complications and fat necrosis of the flap, in addition to donor-site morbidity, with the expected more rectus muscle damage with the more number of perforators harvested in the flap. Surgeons often use their clinical judgement regarding the number of perforators required to adequately perfuse the flap while minimizing abdominal wall trauma. The purpose of this study was to assess the correlation between the number of DIEP perforators and flap outcomes [4–7].

Patients and methods

A prospective review was performed on all DIEP flaps performed over 18 months at Whiston Hospital in the United Kingdom. Patients who underwent free-flap breast reconstruction between January 2020 and June 2021 were included in the study. This included unilateral cases and bilateral cases of DIEP reconstruction. Exclusion criteria were bipedicle DIEP flaps and muscle-sparing TRAM flaps.

The following data were included in the study: preoperative history, physical examination, operative reports, nursing records, outpatient clinic notes, and laboratory data. The parameters included patient characteristics (age, BMI, and associated comorbidities, e.g., hypertension, diabetes, and smoking status), adjuvant oncological treatment (preoperative and postoperative radiotherapy, hormonal treatment, and chemotherapy), operative details (immediate versus delayed, unilateral versus bilateral, mastectomy weight, flap weight, ischemia time, and total operative time), intraoperative complications (venous or arterial thrombosis), postoperative complications (DIEP flap or abdominal site complications), return to theater, hemoglobin loss, fat necrosis, and abdominal wall weakness. The minimum follow-up for patients was 3 months.

Fat necrosis was considered when there was a clinically palpable mass greater than 1 cm in diameter that was present 6 weeks after surgery or radiologically detected fat necrosis or oil cyst. Partial flap loss was considered when there was a flap necrosis of more than 5% of the flap [8].

Flaps were subdivided into three cohorts based on the number of perforators into single, double, and triple perforators comparing demographics, operative details, and outcomes according to the number of perforators.

Data were fed to the computer and analyzed using IBM SPSS software package, version 20.0. (IBM Corp., Armonk, New York, USA). Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean, and SD. Categorical variables were analyzed using the χ^2 or Fisher's exact tests where appropriate, whereas continuous variables were examined with the Wilcoxon rank sum test or the Kruskal–Wallis test. Significance of the obtained results was judged at the 5% level.

Results

A total of 63 patients underwent 72 DIEP flaps performed over 18 months. Overall, 54 patients had unilateral reconstruction, whereas the other nine patients had bilateral reconstruction. The 72 DIEP flaps were divided into three cohorts based on the number of perforators. A total of 25 (34.7%) flaps had one perforator, 26 (36.1%) flaps had two perforators, and 21 (29.2%) flaps had three perforators. The patients' demographic data, past medical history, surgical history, smoking status did not differ significantly between groups (Tables 1 and 2).

Moreover, no significant difference was noted among the three groups regarding the preoperative treatment in the form of radiotherapy, chemotherapy, and hormonal treatment (Table 2). Overall, 44 flaps were used for immediate reconstruction, whereas 28 flaps were used for delayed reconstruction. When comparing the operative details between the cohorts as final flap weight, ischemic time, and number of veins anastomosed, no significant difference was observed (Table 3). Assessment of intraoperative complications in the form of arterial and venous thrombosis, blood loss, need for transfusion, flap outcomes including fat necrosis, and abdominal wall morbidity was done and compared among the three cohorts (Tables 4–5).

Six (8.3%) flaps experienced intraoperative venous thrombosis that was twice the incidence of intraoperative arterial thrombosis that occurred in three (4.2%) flaps only; three (4.2%) flaps showed signs of superficial venous dominance that necessitated a second venous anastomosis with the superficial venous system of the

Table 1 Comparison among the three studied subgroups according to demographic data

	Total (*N*=63)	Perforators			Test of significance	*P*
		Single (*N*=21)	Double (*N*=23)	Triple (*N*=19)		
Age (years)						
Median (minimum–maximum)	51 (28–74)	52 (28–68)	50 (32–74)	51.5 (34–72)	*F*=0.038	0.962
Mean±SD	50.78±8.82	50.75±9.06	50.44±8.34	51.20±9.21		
BMI [*n* (%)]						
Normal	11 (17.5)	3 (14.3)	4 (17.4)	4 (21)		
Overweight	31 (49.2)	10 (47.7)	13 (56.5)	8 (42.1)	χ^2=2.530	^{MC}P=0.932
Obese class 1	19 (30.1)	7 (33.3)	6 (26.1)	6 (31.6)		
Obese class 2	2 (3.2)	1 (4.7)	0	1 (5.3)		
Median (minimum–maximum)	28 (18–36.3)	28.8 (21.5–35.4)	27.1 (21.0–35.7)	27.9 (18.0–36.3)	*F*=0.459	0.634
Mean±SD	28.13±3.43	28.67±3.33	27.69±3.28	28.04±3.67		

F, *F* for analysis of variance test; MC, Monte-Carlo; χ^2, χ^2 test. *P*: *P* value for comparing between the studied subgroups.

Table 2 Comparison among the three studied subgroups according to medical and surgical history and preoperative treatment

Medical and surgical history	Total (*N*=63)	Perforators [*n* (%)]			χ^2	*P*
		Single (*N*=21)	Double (*N*=23)	Triple (*N*=19)		
Previous abdominal surgery	25 (39.7)	9 (42.9)	8 (34.8)	8 (42.1)	0.366	0.833
Comorbidities	7 (11)	2 (9.5)	2 (8.7)	3 (15.8)	0.722	^{MC}P=0.784
DM	2 (3.2)	0	1 (4.35)	1 (5.2)	1.302	^{MC}P=0.759
HTN	4 (6.3)	1 (4.75)	1 (4.35)	2 (10.6)	0.939	^{MC}P=0.672
AF	1 (1.5)	1 (4.75)	0	0	1.858	^{MC}P=0.633
Smoker						
No	48 (76.2)	16 (76.2)	17 (74.0)	15 (79.0)		
Smoker	6 (9.5)	2 (9.5)	2 (8.7)	2 (10.5)	0.717	^{MC}P=0.987
Ex-smoker	9 (14.3)	3 (14.3)	4 (17.3)	2 (10.5)		
Preoperative treatment						
Radiotherapy	33 (52.4)	12 (57.1)	10 (43.5)	11 (57.8)	1.153	0.562
Herceptin	10 (16)	3 (14.3)	3 (13.0)	4 (21)	0.648	^{MC}P=0.832
Hormonal	33 (52.4)	9 (43.0)	11 (48.0)	13 (68.4)	2.915	0.233
Chemo	41 (65)	13 (62)	14 (61)	14 (73.7)	0.892	0.640

AF, atrial fibrillation; DM, diabetes mellitus; HTN, hypertension; MC, Monte-Carlo; χ^2, χ^2 test. *P*: *P* value for comparing among the studied subgroups.

flap to relieve the venous congestion. No significant difference was noted among the three cohorts regarding intraoperative complications. There were two (2.8%) cases of postoperative venous thrombosis, one (4%) case in the single-perforator group, and the other in the two-perforator group (3.8%). Both cases required return to theater for revision of venous anastomoses. One case of postoperative arterial thrombosis happened among the triple-perforator group that required revision of anastomosis, but it thrombosed again later on leading to flap loss. These outcomes did not vary significantly among the cohorts (Table 6).

One (1.3%) case of flap loss was noticed among the double-perforator group, which happened after postoperative arterial thrombosis. Partial flap necrosis was noted in three (4.2%) flaps, one in each perforator group. One flap was managed conservatively (triple-perforator group), whereas two flaps required return to theater for debridement, where conservative management was done for one (single-perforator group) and a thoracodorsal artery perforator flap was done for the third one (double-perforator group). Partial mastectomy flap necrosis occurred in one flap, which required return to theater for debridement and reconstruction by split-thickness skin graft.

Fat necrosis also did not differ significantly across cohorts, occurring clinically in 12 (17.2%) flaps overall. A total of five (19%) flaps experienced this complication in the one-perforator group, five (18.9%) flaps in the two-perforator group also, and two (13.2%) flaps in the three-perforator group. Although this did demonstrate a slightly greater rate of fat necrosis in flaps with single and double perforators than triple, this difference did not reach statistical significance (Table 4).

Correlation between BMI and fat necrosis of DIEP flaps showed potential association between fat necrosis and increasing BMI. This analysis demonstrated that

Table 3 Comparison among the three studied subgroups according to name, timing, and site of procedure

	Total (*N*=63)	Perforators [*n* (%)]			Test of significance	*P*
		Single (*N*=21)	Double (*N*=23)	Triple (*N*=19)		
Name of procedure						
Unilateral DIEP	54 (85.7)	17 (81.0)	20 (87.0)	17 (89.5)	χ^2=0.682	0.821
Bilateral DIEP	9 (14.3)	4 (19.0)	3 (13.0)	2 (10.5)		
Timing operation	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Immediately	44 (61.1)	17 (68.0)	14 (53.8)	13 (62.0)	χ^2=1.082	0.582
Delayed	28 (38.9)	8 (32.0)	12 (46.2)	8 (38.0)		
Mastectomy	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Median (minimum–maximum)	562.5 (158–1438)	653 (240–1438)	515 (158–1100)	590 (280–1175)	*F*=1.343	0.268
Mean±SD	625.3±243.3	684.3±292.9	572.4±194.99	633.3±233.7		
Flap weight	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Median (minimum–maximum)	1064 (420–2536)	1064 (460–2142)	1012.(456–2536)	1132 (420–2280)	*F*=0.250	0.779
Mean±SD	1169.3±459.0	1150.7±413.5	1140.7±489.4	1229.3±471.1		
Final flap weight	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Median (minimum–maximum)	830 (336–1545)	830 (436–1545)	802.5 (336–1474)	864 (390–1435)	*F*=0.195	0.823
Mean±SD	843.9±226.8	848.3±230.5	823.3±231.7	864.1±216.6		
Ischemia time	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Median (minimum–maximum)	92 (37–228)	88 (44–228)	98 (37–205)	89 (40–165)	*F*=0.571	0.567
Mean±SD	95.92±33.80	95.80±35.63	100.68±34.31	90.11±30.41		
Number of veins anastomosed	(*N*=72)	(*N*=25)	(*N*=26)	(*N*=21)		
Single	50 (69.4)	19 (76)	16 (61.5)	15 (71.4)	χ^2=1.311	0.519
Double	22 (30.6)	6 (24)	10 (38.5)	6 (28.6)		
Median (minimum–maximum)	6.76 (3.80–14.33)	6.38 (3.82–12.0)	6.73 (4.0–14.33)	7.20 (3.80–12.12)	*F*=0.139	0.870
Mean±SD	7.07±1.95	6.91±1.85	7.12±2.12	7.20±1.85		

DIEP, deep inferior epigastric perforator; *F*, *F* for analysis of variance test; χ^2, χ^2 test. *P*: *P* value for comparing between the studied subgroups.

Table 4 Comparison among the three studied subgroups according to different parameters

	Total (*N*=63)	Perforators [*n* (%)]			Test of significance	*P*
		Single (*N*=21)	Double (*N*=23)	Triple (*N*=19)		
HB lost (g/l)						
Median (minimum–maximum)	32 (4–75)	35 (12–66)	29 (12–64)	32 (4–75)	*F*=1.384	0.259
Mean±SD	33.07±12.55	36.57±11.92	30.40±10.85	32.96±14.28		
Transfusion	4 (6.4)	2 (9.5)	1 (4.3)	1 (5.3)	χ^2=0.729	^{MC}P=0.832
Intra op. complications	12/72 (19.0)	4/25 (16.0)	5/26 (19.3)	3/21 (14.3)	χ^2=0.289	^{MC}P=0.927
Abdominal wall complications	8/63 (12.7)	2/21 (9.5)	2/23 (8.7)	4/19 (21.0)	χ^2=1.610	0.510
Abdominal hematoma	1 (1.6)	0	0	1 (5.25)	χ^2=2.059	^{MC}P=0.303
Abdominal seroma	1 (1.6)	0	0	1 (5.25)	χ^2=2.059	^{MC}P=0.303
Abdominal wall cellulitis	2 (3.2)	0	1 (4.35)	1 (5.25)	χ^2=1.302	^{MC}P=0.758
Abdominal wound dehiscence	4 (6.3)	2 (9.5)	1 (4.35)	1 (5.25)	χ^2=0.729	^{MC}P=0.831
DIEP complications	10/72 (13.9)	4/25 (16.0)	3/26 (11.5)	3/21 (14.3)	χ^2=0.339	^{MC}P=0.916
Fat necrosis	12/72 (16.7)	5/25 (20.0)	5/26 (19.3)	2/21 (8.5)	χ^2=1.110	^{MC}P=0.672
Abdominal weakness						
No	60 (95.2)	20 (93.9)	22 (96.2)	18 (96.4)		
Abdominal bulge	2 (3.2)	0	1 (3.8)	1 (3.6)	χ^2=3.097	^{MC}P=0.743
Paraumbilical hernia repaired with mesh	1 (1.6)	1 (2.0)	0	0		

DIEP, deep inferior epigastric perforator; MC, Monte-Carlo; χ^2, χ^2 test. *P*: *P* value for comparing between the studied subgroups

patients with BMI more than 25 who underwent DIEP flaps had a greater risk of fat necrosis (Table 7). No significant difference was found in fat necrosis among patients who had received postoperative radiotherapy (19.4%) and those who did not (17.5%) (Table 8). The incidence of fat necrosis was not correlated with the increase in final flap weight (Table 9).

Abdominal donor-site postoperative complications occurred in eight (12.7%) patients; half of them

Table 5 Comparison among the three studied subgroups according to early and late complications

Early and late complications	Total (*N*=72)	Perforators [*n* (%)]			χ^2	^{MC}P
		Single (*N*=25)	Double (*N*=26)	Triple (*N*=21)		
Intraoperative complications						
No	60 (83.3)	21 (84.0)	21 (80.8)	18 (85.8)	0.289	0.929
Arterial complications	3 (4.2)	1 (4.0)	2 (7.7)	0	1.507	0.773
Venous complications	6 (8.3)	2 (8.0)	2 (7.7)	2 (9.5)	0.288	1.000
Superficial venous dominance	3 (4.2)	1 (4.0)	1 (3.8)	1 (4.7)	0.470	1.000
DIEP complications						
No	62 (86.1)	21 (84.0)	23 (88.6)	18 (85.9)	0.339	0.917
DIEP cellulitis	1 (1.4)	0	0	1 (4.7)	2.125	0.294
Partial flap necrosis	3 (4.2)	1 (4.0)	1 (3.8)	1 (4.7)	0.470	1.000
Venous congestion	2 (2.8)	1 (4.0)	1 (3.8)	0	1.041	1.000
Partial mastectomy flap necrosis	1 (1.4)	1 (4.0)	0	0	1.746	1.000
Flap loss	1 (1.3)	0	1 (3.8)	0	1.698	1.000
DIEP hematoma	2 (2.8)	1 (4.0)	0	1 (4.7)	1.468	0.524

DIEP, deep inferior epigastric perforator; MC, Monte-Carlo; χ^2, χ^2 test. *P*: *P* value for comparing among the studied subgroups.

Table 6 Comparison among the three studied subgroups according to return to theater

	Total (*N*=63)	Perforators [*n* (%)]			χ^2	*P*
		Single (*N*=21)	Double (*N*=23)	Triple (*N*=19)		
Return to theater	8 (12.7)	2 (9.5)	4 (17.4)	2 ((10.5)	0.741	0725
Debridement	4 (6.3)	1 (4.7)	2 (8.7)	1 (5.25)		
Hematoma evacuation	1 (1.6)	0	0	1 (5.25)	5.353	0.980
Ischemic flap	1 (1.6)	0	1 (4.3)	0		
Venous congestion	2 (3.2)	1 (4.7)	1 (4.3)	0		

MC, Monte-Carlo; χ^2, χ^2 test. *P*: *P* value for comparing among the studied subgroups.

Table 7 Relation between fat necrosis and BMI in total patients

BMI (kg/m^2)	Fat necrosis [*n* (%)]		χ^2	*P*
	No (*N*=51)	Yes (*N*=12)		
Normal (18 24.9)	9 (17.6)	3 (27.2)		
Overweight (25 29.9)	25 (49.2)	6 (45.5)		
Obese class 1 (30–34.9)	16 (31.3)	3 (27.2)	1.244	^{MC}P=0.855
Obese class 2 (35–39.9)	1 (1.9)	0		
<25	9 (17.6)	3 (25)	0.585	^{FE}P=0.425
≥25	42 (82.4)	9 (75)		

FE, Fisher exact; MC, Monte-Carlo; χ^2: χ^2 test. *P*: *P* value for association among different categories.

Table 8 Relation between postoperative radiotherapy and fat necrosis incidence in total patients

Fat necrosis incidence	Postoperative radiotherapy [*n* (%)]		χ^2	^{FE}P
	No (*N*=63)	Yes (*N*=9)		
No	52 (82.5)	8 (88.9)	0.229	1.000
Yes	11 (17.5)	1 (19.4)		

FE, Fisher exact; χ^2, χ^2 test. *P*: *P* value for association among different categories.

Table 9 Relation between final flap weight and fat necrosis in total patients

Fat necrosis	*N*	Final flap weight		*t*	*P*
		Median (minimum–maximum)	Mean±SD		
No	60	855 (336–1545)	860.2 ± 234.4	0.454	0.652
Yes	12	795 (495–1325)	827.4 ± 194.7		

t, Student *t* test. *P*: *P* value for comparing among final flap weight and fat necrosis.

happened in the triple-perforator group. Late abdominal complications in the form of abdominal bulge and hernia occurred in three (4.5%) patients. Despite the increased incidence of abdominal complications among the triple-perforator group, there was no statistically significant difference among the cohort groups (Table 7).

Discussion

Successful microsurgical breast reconstruction is dependent on adequacy of vascular perfusion to the flap. With refinement of microsurgical techniques and enhancement of flap design toward minimizing abdominal donor-site morbidity, the adequate number of perforators harvested for sufficient flap perfusion with minimal flap complications was always a question.

The aim of this study was to assess the correlation between the perforator number and the overall flap outcome. Our findings show that the DIEP perforator number does not appear to affect flap survival. However, preserving a greater number of perforators especially those on the same row with minimal sacrifice of rectus muscle may decrease the likelihood of postoperative fat necrosis. No difference in abdominal wall morbidity was noticed with increasing number of perforators harvested.

Preoperative planning is done for every patient with a computerized tomography angiography scan followed by marking the perforator anatomy on *X* and *Y* axis grid relative to the umbilicus. Handheld Doppler assessment of perforator anatomy is done on the day of surgery. Flap is raised from lateral to medial direction with harvest of superficial inferior epigastric vein bilaterally, followed by identifying and isolating all the medial and lateral row perforating vessels, which are assessed regarding caliber and location. Flow through the vessels was assessed using a sterile Doppler probe. If a single perforator is centrally located with a large artery (1.5 mm or more) and strong doppler signal, then we will proceed with a single-perforator DIEP flap dissection. If no single, dominant perforator seems to be present with the existence of three medium-size perforators in the same row that require little to no sacrifice of the rectus abdominis muscle, a multiple-perforator DIEP flap will be the choice. Zone IV is discarded in all flaps.

Once the perforators and the flap pedicle are dissected, contralateral flap dissection is performed with temporary clamping of contralateral perforators leaving the flap isolated on its blood supply. The flap then is evaluated in situ after wiping off all the blood and assessed for any signs of venous congestion. If any signs of venous congestion are noted, then a second venous anastomosis is considered with the superficial epigastric system. This algorithm has proven to provide successful reconstructions with low rates of flap loss and low accompanying donor-site morbidity.

In this study, it was found that the number of perforators harvested with DIEP flaps does not significantly affect the flap loss rate. In addition, fat necrosis did not differ significantly between the cohorts despite being of higher incidence in the single group when compared with the multiple-perforator group. This association may be clarified in the future by involving a larger cohort. This may clarify better flap perfusion in the multiple-perforator group as more abundant blood supply is directed to the periphery of the flap. Moreover, data analysis revealed that the number of perforators does not appear to be significantly associated with other flap complications.

Despite the increased incidence of abdominal complications among the multiple perforator group, no statistically significant difference was noted among the cohort.

The literature contains disparate findings regarding the correlation between the perforator number and overall flap complications, especially the incidence of fat necrosis among DIEP flap. Gill *et al.* [9] reported in a retrospective review of 758 DIEP flap that a significant increase in the rate of overall flap complication was found to increase with the increase in number of perforators. Fat necrosis was found also to increase with the more number of perforators harvested, despite statistical significance being not achieved. Their elucidation was that generally the less the number of perforators harvested within the flap, the larger the caliber and flow these perforators have, which subsequently improves flap perfusion and minimizes complications. This opinion was supported by a research study published in 2014 by Douglas *et al.* [10] who conducted a flow measurement study using indocyanine-green-fluorescence-angiography scans on fat and skin of zone IV of DIEP flap and found significant difference in perfusion of zone IV, which was better among single perforators than double perforators.

On the contrary, several studies found an inverse relationship between the number of perforators and the incidence of fat necrosis. In a prospective study, Bauman and colleagues analyzed the relationship between the perforator number and the fat necrosis rate in muscle-sparing TRAM flaps, DIEP flaps, and SIEA flaps. It was found that the incidence of fat necrosis was five times more among flaps with one or two perforators when compared with flaps with three or more perforators. Lee and colleagues published a 5-year retrospective review of DIEP flap in 2010, where the incidence of fat necrosis in single perforator was twice that among the triple-perforator group, with no difference in abdominal bulge among single-perforator, double-perforator, and triple-perforator groups. Moreover, Grover an colleagues performed a 5-year retrospective review of the outcomes of DIEP flaps in relation to the number of perforators, where they found that fat necrosis was more among single-perforator group when compared with multiple-perforator group; however, no significant difference was found in fat necrosis or other complications such as flap loss when comparing single-perforator, double-perforator, and triple-perforator groups. Our findings are in harmony with these studies [11–13].

This study has some limitations. The first is the relative smaller cohort of patients involved in the study which may have affected the presence of significant correlation of some parameters such as fat necrosis, which showed increased incidence among single than triple perforators but did not reach statistical significance. The second is some studies suggested that rates of abdominal morbidity are proportionate with the increase in the number of perforators harvested in the flap, which we did not find to be corelated. This result may be related to the intraoperative technique we use in perforator harvest, which avoids harvesting of flaps based on perforators from both medial and lateral branches of DIEA. Flaps were harvested on perforators from the same vascular row to minimize muscle damage. So, it may be that the muscle and nerve sacrifice is the factor that causes higher morbidity and not the perforator number. Moreover, the patient's lifestyle and physical activity may affect the abdominal morbidity. Another limitation is that we did not compare the aesthetic results and patient satisfaction in the study. Finally, the nonrandom selection of perforator numbers, which was based on intraoperative assessment of perfusion by an experienced surgeon, may affect the results.

Conclusion

The number of DIEP flap perforators does not significantly affect the flap loss rates or abdominal complications rates. However, the rate of fat necrosis may be higher in single-perforator DIEP flaps, suggesting that multiple perforators when feasible to be done with minimal muscle damage may lead to better flap perfusion.

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Conflicts of interest

Nothing to declare.

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