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Starting an autologous breast reconstruction program after plastic surgical training. Is it as good as it gets?

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Summary *Background:* Today, the deep inferior epigastric perforator (DIEP) flap is considered to be the gold standard in microvascular breast reconstruction. Although this procedure is known as technically demanding, novice plastic surgeons must be able to perform these procedures to meet the rising demand. The purpose of this study was to evaluate if the young junior professional is trained adequately to set up and safely perform microsurgical breast reconstructions.
Methods: We compared outcomes of three identically trained novice plastic surgeons who introduced the DIEP flap in their working environment. Their hospitals differed in size and experience in microsurgery. Outcomes were compared between all start-ups and a center of excellence (EMC).
Results: A total of 152 DIEP flaps were performed in 123 patients among all start-ups together. Baseline characteristics and major complications were comparable between all groups. The total flap loss rate was 2% in the start-ups versus 3.9% in the control group ($p = 0.5$).
Although there seems to be a trend in a longer operating time in both training and nontraining academic centers, no statistical significance was found between start-ups ($p = 0.13$) and the control group ($p = 0.17$). However, a learning curve seems to be present when it comes to

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duration of surgery and is greatest in the community centers with zero experience in microsurgery (ZGT $p = 0.002$, Amphia $p = 0.065$). The same accounts for hospital stay.
Conclusion: Although there seems to be a learning curve in terms of duration of surgery in hospitals with no experience in microsurgery, it is safe to perform microvascular breast reconstructions as a novice plastic surgeon.

Introduction

Since its introduction, autologous breast reconstruction has gained popularity. Because of its little donor site morbidity and high satisfaction rate, the deep inferior epigastric perforator (DIEP) flap is considered to be the gold standard nowadays. With the increasing popularity of this procedure, the demand from patients grows. In addition, with more surgeons being trained in microsurgery, the availability of skills is increasing.

The Dutch guideline[1] for breast reconstruction poses an annual number of minimum 20 patients to provide good care. Other factors that contribute to a successfully performed microsurgical breast reconstruction are training of surgical staff, nurses, and hospital facilities.[2] Hence, studies historically advocate DIEP flap programs to be concentrated solely to academic centers. However, in recent years, a number of studies have shown that microsurgical breast reconstruction can be performed safely in a community hospital by trained senior surgeons.[2-4]

Although the perspective of experts in the nonacademic setting is studied frequently,[2-4] the perspective of the young, junior professionals trained in microsurgery is poorly addressed. The question rises whether a junior surgeon can safely start a microsurgical program in a center where no microsurgery or DIEP flaps are performed. Moreover, what are the factors that influence quality in surgery and outcome?

The purpose of this multicenter study is to evaluate the outcomes and complications of DIEP flap breast reconstructions performed by novice plastic surgeons in nonexperienced centers. Is plastic surgery training adequate to meet the standard of a center of excellence?

Patients and methods

Surgeon selection

Three identically trained novice plastic surgeons were selected. Plastic surgery training programs by these surgeons consisted of a 2-year surgical residency and a 4-year plastic surgery residency. Training was done in a major microsurgical center (EMC) where trainees were at that time exposed to one or two free flaps per week, often one of them being a DIEP flap. Although one surgeon did an additional six months microsurgical fellowship, we concluded that there was no significant difference in training at the start of individual careers as a consultant.

In January 2013, an autologous breast reconstruction program was set up in three different hospitals by each surgeon. In each of these three hospitals, one novice plastic surgeon led the DIEP flap procedure. These three surgeons received training in the same academic center (EMC) and the same year gained similar experience in the field of microsurgery and autologous breast reconstruction in particular.

Hospital selection

The study included three hospitals where each surgeon started their microsurgical program. A small community hospital (ZGT) and a large community hospital (Amphia) with no experience in microsurgery were included. In contrast to these community hospitals, the selected academic center (LUMC) had experience in microsurgery but not in perforator flap surgery. Finally, a center of excellence was selected as the control group (EMC). In this academic training center, microvascular procedures are mostly done by an experienced surgeon accompanied by a resident or fellow and a junior trainee or intern. In the community centers, surgeries were performed by two board certified surgeons (ZGT/Amphia) or by one surgeon and a house officer (LUMC).

Patient selection

Patients who had uni- or bilateral DIEP flaps performed between January 2013 and July 2015 were selected. Basic characteristics and outcomes were compared with the academic training center (EMC) and years of experience in microsurgery. The last 152 flaps in 115 patients until July 2015 were selected in this center of excellence.

Data definitions

Patient characteristics include BMI, hypertension, diabetes, smoking, and radiotherapy; these factors might influence outcomes.[5] Abdominal scars exclude scars caused by laparoscopy. Complications can occur within 30 days after surgery. Partial flap loss is defined as partial necrosis of the flap, which requires reoperation, with no total flap loss. A follow-up of six months was maintained. Hospital stay is defined as the time from admission until the day of discharge.

Data collection

After approval of the medical ethical committee, a database was programmed using Surveymonkey, collecting

Table 1 Patient characteristics of a total of 152 DIEP flaps.

	ZGT *n*%	Amphia *n*%	LUMC *n*%	*p*-value	Total start-ups *n*%	EMC *n*%	start-ups vs. EMC *p*-value
Patients (*n*)	38	41	44		123	115	
DIEP flaps (*n*)	46	41	65		152	152	
Mean age, years (SD)	50 (9.4)	50 (9.9)	49 (10.4)	0.94	50 (9.8)	47 (10.4)	0.53
Mean BMI (SD)	27 (3.6)	27 (2.3)	27 (3.0)	0.99	27 (3.0)	27 (3.6)	0.29
Smoking	0 (0)	3 (7.3)	0 (0)	0.02*	3 (2)	0 (0)	0.25
Diabetes	1 (2.2)	2 (4.9)	0 (0)	0.11	3 (2)	8 (5.3)	0.22
Hypertension	4 (8.7)	9 (22)	11 (16.9)	0.23	24 (15.8)	26 (17.1)	0.87
Abdominal scar*	7 (18.4)	16 (39)	12 (27.3)	0.13	35 (28.5)	27 (23.5)	0.46
Unilateral*	30 (78.9)	41 (100)	23 (52.3)	<0.01	94 (76.4)	70 (61)	<0.01**
Radiotherapy	15 (32.6)	22 (53.7)	16 (24.6)	<0.01	53 (34.9)	28 (18.4)	<0.01***
Chemotherapy	19 (41.3)	35 (85.4)	33 (50.8)	<0.01	87 (57.2)	60 (39.5)	<0.01***

SD = standard deviation.

****After Buonferonni-Holm correction; significance between Amphia-LUMC (p= <0.01), Amphia-ZGT (p= <0.01), and Amphia-EMC (p= <0.01).

* Statistical analysis over number of patients instead of number of flaps.

*No significance was found between the groups after Buonferonni-Holm correction, except for Amphia-EMC ($p = 0.009$).

** After Buonferonni-Holm correction; significance between Amphia-LUMC (p= <0.01), Amphia-ZGT ($p = 0.002$), and Amphia-EMC (p= <0.01).

*** After Buonferonni-Holm correction; significance between Amphia-LUMC ($p = 0.002$), LUMC-ZGT ($p = 0.009$), ZGT-EMC (0.002), and Amphia-EMC (p= <0.01).

data retrospectively. Data were exported into SPSS to perform statistical analysis.

Data analysis

SPSS version 22.0 was used for statistical analysis. Comparison of outcome parameters was carried out by Fisher's exact test. Means were compared with one-way Anova test and median with Kruskal Wallis and Mann-Whitney *U* test. For multiple comparisons, Bonferroni-Holm tests were performed. For statistical analysis of learning curves, only unilateral cases were selected.

A *p*-value of less that 0.05 was considered statistically significant.

ZGT: Ziekenhuis Groep Twente
LUMC: Leids Universitair Medisch Centrum
EMC: Erasmus Medisch Centrum.

Results

Patient characteristics

Between January 2013 and July 2015, 152 DIEP flaps in 123 patients were performed in the three start-up hospitals. The mean age was 50 years at the time of operation, which was comparable in all hospitals ($p = 0.53$). All women had a mean body mass index (BMI) of 27 ($p = 0.29$).

Smoking during the time of reconstruction was only reported in Amphia in three patients ($p = 0.02$). In other hospitals, smoking was an absolute contraindication. Diabetes and hypertension were comparable in all hospitals ($p = 0.22$).

There were no significant differences in the number of women with previous abdominal surgery ($p = 0.46$). However, radiotherapy and chemotherapy prior to surgery were significantly different. Half of the patients (53.7%) treated in Amphia had radiotherapy on the operated side, whereas patients from other hospitals had less (p=<0.01). Chemotherapy occurred more often in patients from Amphia as well (85.4%) (p=<0.01).

Furthermore, Amphia had only done unilateral DIEP reconstructions, whereas ZGT had done 78.9% unilateral DIEP reconstructions and LUMC accounted for 52.3% (p=<0.01). Unilateral DIEPs were performed in 61% of all cases in the university hospital (p=<0.01). For a more detailed description, see Table 1.

Operative details and complications

Although there seems to be a trend in a longer operating time in both academic hospitals (LUMC 425 min and EMC 418 min) compared to the nonacademic hospitals (ZGT 381 min and Amphia 383 min), when it comes to unilateral DIEP flaps, no significant differences were found between these hospitals ($p = 0.17$). Both academic hospitals did microsurgical breast reconstruction with less plastic surgeons (mean 2 and 2 vs. 1.4 and 1.33).

Statistical differences were found in the mean number of perforators used as well as the use of a coupler device. For detailed description, see Table 2.

None of the postoperative complications of the acceptor site was significantly different. See Table 3.

Total flap loss occurred in all start-up hospitals once (2.2%, 2.4%, 1.5%, respectively) ($p = 1.00$). In the center of excellence, total flap loss occurred in 3.9% ($n = 6$) of all flaps ($p = 0.50$).

The occurrence of partial flap loss is comparable; twice in ZGT (4.3%), once in Amphia and LUMC (2.4% and 1.5%, respectively), and six times in EMC (3.9%) ($p = 0.75$).

Table 2 Operative details of unilateral DIEP flaps.

	ZGT *n*%	Amphia *n*%	LUMC *n*%	*p*-value	Total start-ups *n*%	EMC *n*%	Start-ups vs. EMC *p*-value
Unilateral DIEP flaps	30	41	23		94	69	
Duration of surgery	381	383	425	0.13	393	418	0.17
Mean (SD) in min	(94.8)	(76.7)	(93.1)		(88.0)	(128.3)	
Mean nr of surgeons (SD)	2 (0.18)	2 (0.00)	1.4 (0.5)	<0.01	1.9 (0.38)	1.33 (0.5)	<0.01*
Mean nr of perforators (SD)	2.3 (0.76)	1.8 (0.57)	1.6 (0.79)	0.003	1.9 (0.73)	1.4 (0.78)	<0.01**
Nr of pt coupler use	11 (36.7)	41 (100)	15 (65.2)	<0.01	67 (70.5)	3 (3.4)	<0.01***

SD = standard deviation.
* Post-Hoc Tukey correction: statistical significance between Amphia-LUMC, Amphia-EMC, LUMC-ZGT, and ZGT-EMC (all $p < 0.01$).
** Post-Hoc Tukey correction: statistical significance between Amphia-ZGT ($p = 0.014$), LUMC-ZGT ($p = 0.004$), Amphia-EMC ($p = 0.02$), and ZGT-EMC ($p = <0.01$).
*** After Buonferroni-Holm correction: statistical significance between all groups ($p = <0.01$), except for LUMC-ZGT ($p = 0.0$).

Table 3 Major complications of all (uni- and bilateral) DIEP flaps within 30 days.

	ZGT *n*%	Amphia n%	LUMC n%	*p*-value	Total start-ups *n*%	EMC *n*%	Start-ups vs. EMC *p*-value
DIEP flaps (*n*)	46	41	65		152	152	
Acceptorsite							
Total flap loss	1 (2.2)	1 (2.4)	1 (1.5)	1.00	3 (2.0)	6 (3.9)	0.50
Partial flap loss	2 (4.3)	1 (2.4)	1 (1.5)	0.82	4 (2.6)	6 (3.9)	0.75
Compromised flap circ	6 (13)	6 (14.6)	3 (4.6)	0.15	15 (9.9)	8 (5.3)	0.19
Hemorrhage	4 (8.7)	3 (7.3)	2 (3.1)	0.47	9 (5.9)	3 (2)	0.14
Arterial insuff	1 (2.2)	2 (4.9)	1 (1.5)	0.34	4 (2.6)	3 (2)	1.00
Venous insuff	1 (2.2)	1 (2.4)	0 (0)	0.65	2 (1.3)	2 (1.3)	1.00
Patients (*n*)	38	41	44		123	115	
Donorsite*							
Reoperation due to							
Hemorrhage	1 (2.6)	0 (0)	0 (0)	0.31	1 (0.8)	0 (0)	1.00
Wound dehiscence	1 (2.6)	0 (0)	0 (0)	0.31	1 (0.8)	2 (1.7)	0.61
Infection	1 (2.6)	0 (0)	0 (0)	0.31	1 (0.8)	2 (1.7)	0.61
Medical*							
Embolus	0 (0)	0 (0)	4 (9.1)	0.03**	4 (3.3)	2 (1.7)	0.69
ICU admission	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	-
Death	0 (0)	0 (0)	0 (0)	-	0 (0)	0 (0)	-

* Statistical analysis over number of patients.
** After Buonferonni-Holm correction, no statistical signficance was found between the groups.

Compromised flap circulation due to hemorrhage seemed to occur more often in start-ups; however, no significant difference was found ($p = 0.14$). Reoperation due to arterial or venous insufficiency was all comparable ($p = 1.00$).

Donor site complications were also not significantly different except for embolism. Four patients operated in LUMC have had an embolus (9%), whereas other start-ups had none ($p = 0.03$). However, after Bonferroni-Holm correction, no statistical significance was found between all groups.

Learning curve

Table 4 and Figures 1–4 show the results of a potential learning curve in unilateral DIEP flaps. The median time of the surgical procedure decreased significantly in the small community hospital (ZGT, $p = 0.002$). Although it does not meet the level of statistical significance ($p = 0.065$), Amphia has made a large progression as well. No difference was found in median operating time in both academic centers (LUMC and EMC) (Table 4).

Figures 1–4 show the duration of surgery over time as well as the rate of flap failure. As shown in Figure 1, partial or total flap loss occurred in the first surgery. Although revision was required in the surgery, it was successful. The same accounts for Amphia. Figure 3 shows no flap failure. Flap failures in LUMC were only in bilateral DIEP flaps, which are not shown. An obvious trend is visible in duration of surgery, especially in two nonacademic centers (Figures 1 and 2). Figure 4 shows all start-ups together, and no flap failure is seen in the second half of all surgeries.

When comparing hospital stays, there is a significant decrease in days of admission when comparing the first and last ten surgeries in ZGT ($p = 0.023$) (Table 4).

Table 5 shows the postoperative details. On average, patients were admitted in the hospital for six days, with a

Table 4 Learning curve; comparison between the first and last ten patients for duration of surgery (in min.) and hospital stay (in days).

	ZGT	Amphia	LUMC	Total start-ups	*p*-value	EMC
Median duration first 10 surgeries	437	420	453	431	0.95	493
In minutes (range)	(303-613)	(300-551)	(278-679)	(278-679)		(270-930)
Median duration last 10 surgeries	313	349	402	354	0.08	476
In minutes (range)	(244-422)	(314-405)	(216-556)	(216-556)		(322-677)
p-value	0.002	0.065	0.436	0.01		0.78
Median hospital stay first 10 pt	7.5 (6-15)	6 (6-15)	7 (5-9)	7 (5-15)	0.91	6 (4-8)
Median hospital stay last 10 pt	6 (5-10)	6 (5-7)	6 (5-7)	6 (5-10)	0.49	5 (5-7)
p-value	0.023	0.91	0.089	0.004		0.315

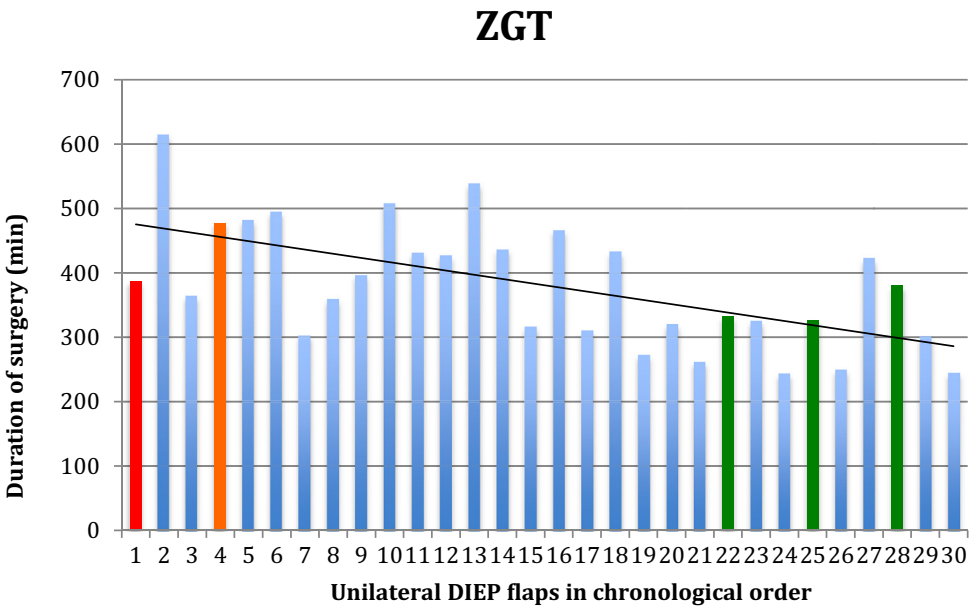

Figure 1

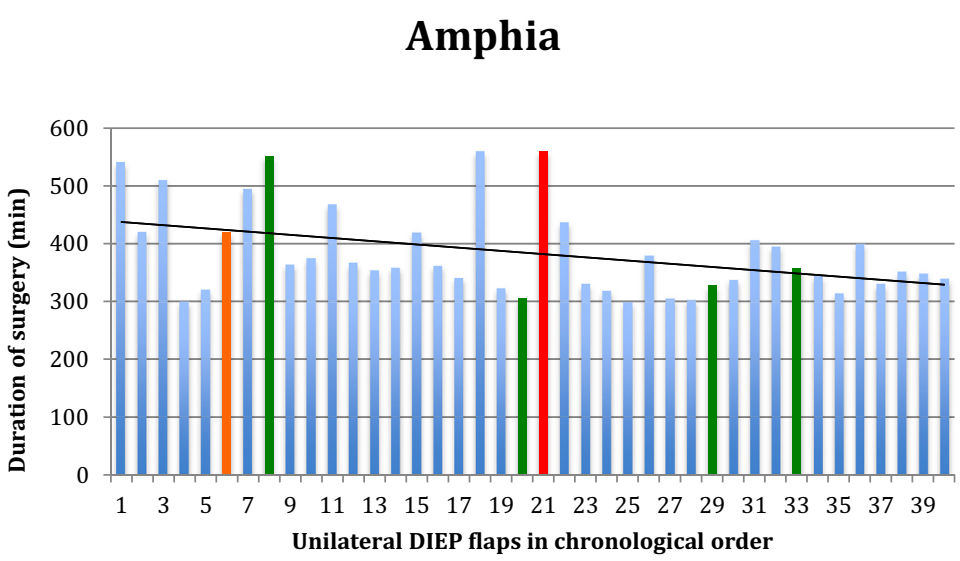

Figure 2

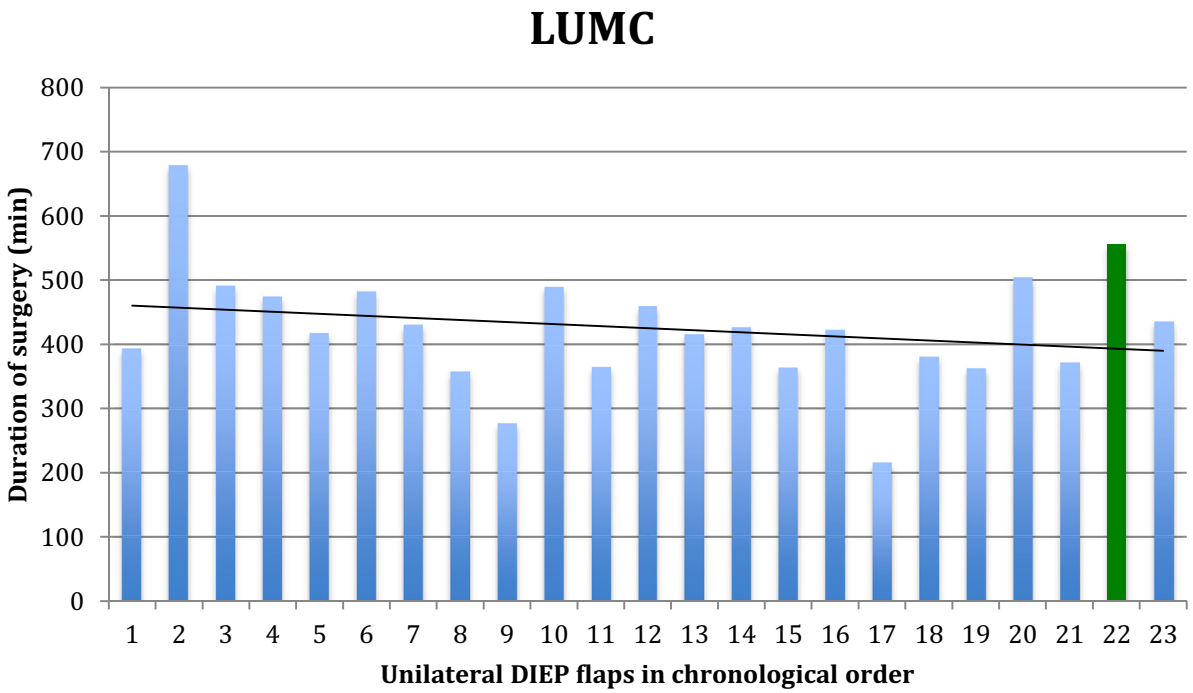

Figure 3

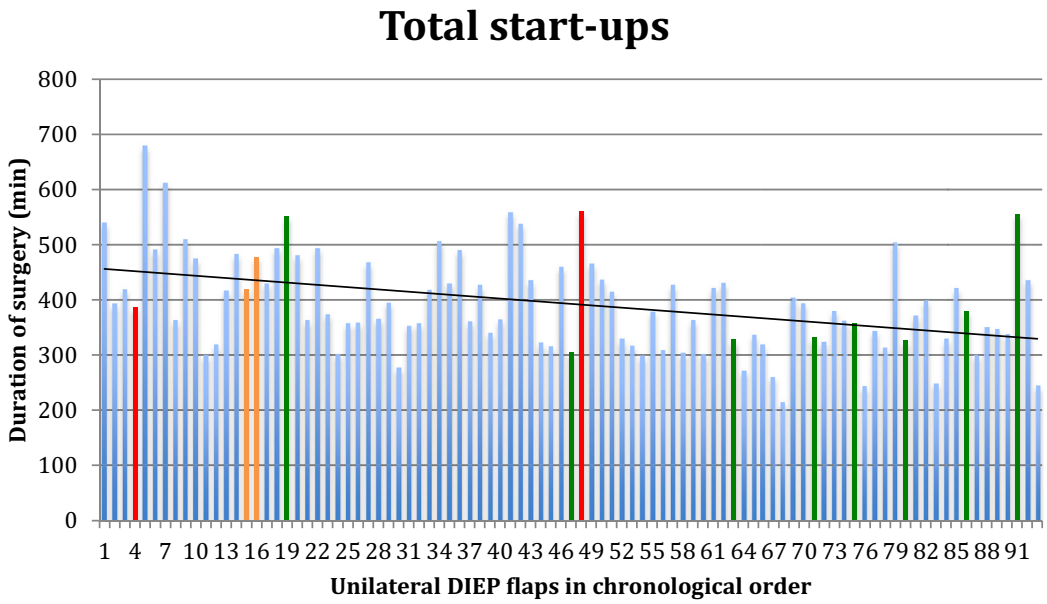

Figure 1-4 Unilateral DIEP flap learning curve; the duration of surgery per patient in chronological order. The red color represents total flap loss, the orange color represents partial flap loss, and the green color represents cases with successful surgical revision. The black line shows the trend of the duration of surgery.[11]

range of 5–19 days. The median hospital stay was the longest in ZGT, which was significantly higher than in other hospitals.

Thrombosis prophylaxis was given by low molecular weight heparin in almost all patients. Postoperative pressure stocks were not used in LUMC. Anticoagulants were used on a regular basis in Amphia, whereas in the other hospitals they were given when deemed necessary.

Discussion

Since its introduction in 1989,[6] microvascular breast reconstructions have gained popularity tremendously. In the Netherlands, declaration of free-flap reconstruction, including microsurgical breast reconstruction, has increased with 67% over the past two years.[7] It is expected to rise even more and, therefore, every plastic surgeon needs to

Table 5 Postoperative details for all (uni-and bilateral) DIEP flaps.

	ZGT *n*%	Amphia n%	LUMC *n*%	*p*-value	Total start-ups n%	EMC *n*%	Start-ups vs. EMC *p*-value
Patients (*n*)	38	41	44		123	115	
Median hospital stay*	7	6	6	0.002	6	6	<0.01*
In days (range)	(5-15)	(5-15)	(5-19)		(5-19)	(4-19)	
Trombosis profylaxis*							
LMWH	38 (100)	38 (92.7)	44 (100)	0.33	120 (97.6)	115 (100)	0.25
Stocks	38 (100)	41 (100)	0 (0)	<0.01	79 (64.2)	115 (100)	<0.01**
Anticoagulants	1 (2.6)	41 (100)	0 (0)	<0.01	39 (31.7)	5 (4.3)	<0.01***

SD = standard deviation.

* Per patient.

*After Buonferroni-Holm correction: statistical significance between ZGT-EMC (p=<0.01), ZGT-Amphia (p=<0.01), and ZGT-LUMC (p = 0.008).

** After Buonferroni-Holm correction: statistical significance between ZGT-LUMC (p=<0.01), Amphia-LUMC (p=<0.01), and LUMC-EMC (p=<0.01).

*** After Buonferroni-Holm correction: statistical significance between Amphia-ZGT (p=<0.01), Amphia-LUMC (p=<0.01), and Amphia-EMC (p=<0.01).

be able to provide the whole spectrum of breast reconstruction, including free flaps. Nevertheless, there is restraint among plastic surgeons with little microsurgical experience because of the required skills and the fear of encountering setbacks. Study has shown that nearly one fifth of all novice plastic surgeons in the United States consider that their training in microsurgery was not adequate to perform autologous breast reconstruction and, therefore, prefer reconstruction with breast implants or perforator flaps.[8] This raises the question; are novice plastic surgeons trained well enough to perform an autologous breast reconstruction such as a DIEP flap nowadays?

One plastic surgeon has shown his experience right after completion of his training and compared his outcome to literature.[9] Except for partial flap loss and venous complications, results were comparable. Orbay[9] changed his strategy, and because he clamps the venous perforator and leaves the largest perforator open before harvesting the flap, his venous occlusion rates have decreased. Furthermore, Orbay mentioned that the lack of a standard definition for partial flap loss may explain the variability in literature.

We compared three young professionals with the same background in microsurgical training who started their career in a hospital not performing DIEP flaps. Most baseline characteristics were equal in all three hospitals and compared to our control group (center of excellence), except for smoking, radiotherapy, and chemotherapy. Importantly, Amphia did only perform unilateral DIEP flaps, whereas LUMC performed bilateral reconstruction in nearly half of their patients.

When it comes to operative details, we have not seen a significant difference in the duration of surgery. Nonetheless, the academic start-up (LUMC) and the academic control group seem to have a longer operating time compared to the two nonacademic start-ups (ZGT and Amphia). This could be because of the number of plastic surgeons participating. As shown in Table 2, both nonacademic hospitals perform the surgery with two plastic surgeons, whereas the academic surgeons are frequently accompanied by residents. It is of note that training centers have a different role as a teaching hospital in comparison with the non-training centers. This means that reduction in operating times is unlikely to be seen in data such as operating time. Moreover, the study shows that plastic surgeons were adequately trained through this training program.

Almost all complications are comparable in different hospitals. Our total and partial flap loss rates are comparable with literature.[9-11] Compromised flap circulation, meaning returning to theater because of an embolus or hemorrhage, is also not significantly different. As mentioned before, it should be noted that there is a lack of standard definitions for partial flap failure, so one should be regardful to compare outcome with literature.[12] Postoperative monitoring of the DIEP flap was done in a similar fashion in every hospital; inspection and Doppler monitoring at standardized intervals of one, two, and four hours in the first three days.

A symptomatic pulmonary embolism occurred four times in LUMC (9%) and twice in EMC (1.9%). Although not statistically different after Bonferroni-Holm correction, it is worth mentioning, as the other start-ups had none. In our data, it seems that wearing postoperative stocks or pressure pumps is of influence (Table 5). To clarify, symptomatic embolisms only occurred in LUMC. At the same time, LUMC is the only hospital in which patients are not given stocks postoperatively. However, a study has shown that BMI and BRCA were significant predictors for symptomatic pulmonary embolism, whereas wearing foot pumps or pneumatics stockings was not.[13] In those four patients, two were BRCA positive. Their BMI was average. Furthermore, it should be noted that three of four embolisms occurred in patients with bilateral reconstruction. Hofer et al.[10] experienced the same (11% in bilateral and 0% in unilateral DIEP flaps) and started with pneumatic pressure stockings in bilateral reconstructions.

Learning curve

As microsurgical breast reconstruction is known as a technically demanding procedure, one should expect a learning curve. Many studies have been performed, reporting or

trying to overcome the first problems.[5,9–11,14,15] For example, Busic[15] described the learning curve, wherein the total flap loss rates decreased from 9.5% to 0% and partial flap loss rate from 31% to 0%. The first outcomes almost led to abandoning this procedure, but by visiting and learning from a center of excellence, the complication rate was decreased. An absolute cut-off point, when one could expect to do better, is not mentioned. Nonetheless, Hofer et al.[10] did find a cut-off point. Flap complications were significantly higher in the first 30 DIEP flaps compared to the following 145. However, Grinsell et al.[14] contradict these findings. In their series of 214 DIEP and SIEA flaps of one senior surgeon, no changes in complication rates were seen, suggesting that adequate training can prevent higher complication rates due to a learning curve. Yet, these findings show results of a senior surgeon starting with microsurgical breast reconstruction. Our study shows that a novice plastic surgeon has similar results in complication rates compared to a center of excellence. However, a learning curve in terms of operating time is expected as seen in our results. Bodin et al.[11] described their learning curve and saw a drastic decrease in duration of surgery: 415 min in the first 22 patients vs. 233 min in the last 22 patients. The same accounts for our community centers with no previous experience in microsurgery whatsoever. Our start-up with experience in microsurgery (LUMC) did better over time but not as drastic as the others. As expected, the center of excellence showed no significant decrease in operating time. Presumably, a learning curve in microsurgery is not only apparent in the surgeon itself but also in the surgeon's staff. Moreover, the initial duration of surgery in all start-ups are comparable to the mean duration of surgery in the control group, but once they got more experienced, the duration of surgery was shorter than compared to the center of excellence. However, this is expected, as the center of excellence is a training center.

Training of surgical staff can decrease the duration of surgery and will contribute, in turn, to a faster recovery, a decrease in hospital stay (Table 4), and, therefore, less costs. Therefore, microsurgical breast reconstruction in a nonacademic center can be even more cost-effective compared to an academic center.

A strength of this study is the fact that all novice surgeons are identically trained (i.e., same training center and same graduation year) so no bias in experience exists. Furthermore, they set up their breast reconstruction program at the exact same time. On the other hand, this also causes a limitation of this study; the number of patients included. We could not expand our data, as there were no more DIEP flaps performed. However, as we used the Bonferroni–Holm correction for multiple comparisons, we could compare all start-ups together with the control group, thereby increasing our power.

Conclusion

It is safe to start with DIEP flap reconstructions as a novice plastic surgeon. Although there is a learning curve in nonacademic centers with no microsurgical experience when it comes to the duration of surgery, complications are comparable to a center of excellence. It is safe to start or perform DIEP flap reconstruction in any kind of hospital.

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None.

Declaration of Competing Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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