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MICROSURGERY

Case Report

A FIVE-YEAR SINGLE-SURGEON EXPERIENCE: CONTINUOUS SERIES OF MICROVASCULAR FREE FLAP AND FACTORS INFLUENCING ITS VIABILITY

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ABSTRACT

Background: Over the past years, microvascular free tissue transfer has become increasingly popular in the field of plastic surgery. Our center has also been actively performing these complex surgeries for extensive defect closure. In this study spanning five years, our objective is to examine the challenges commonly encountered in free flap reconstruction and identify factors that contribute to the failure of such flaps, with the ultimate goal of enhancing our learning curve.
Methods: This article presents a retrospective analysis of all patients who underwent microvascular free tissue transfer procedures performed by a single surgeon (PA) and teams of Plastic Reconstructive and Aesthetic Surgery residents from 2014 to 2018. Multivariate analysis was conducted to identify the factors associated with free flap failure.
Results: Between 2014 and 2018, a total of 203 microvascular free tissue transfers were performed to reconstruct defects at various anatomical sites. The overall viable flap rate for microvascular free flap reconstructions, irrespective of the indication or anatomical location, was found to be 90.6%. The type of flap, whether it was a perforator or non-perforator flap, emerged as the main significant factor influencing free flap viability.
Conclusion: Microvascular free tissue transfer represents an excellent reconstructive option for addressing large defects requiring extensive or composite flaps. By acknowledging the factors contributing to free flap failure, we can optimize outcomes and provide the best possible results for our patients.

Keywords: *Free tissue flap, Microsurgery, Tissue survival*

Latar belakang: Selama beberapa tahun terakhir, transfer jaringan bebas mikrovaskular telah menjadi semakin populer dalam bidang bedah plastik. Pusat kami juga telah aktif melakukan operasi kompleks ini untuk penutupan defek yang luas. Dalam studi ini yang berlangsung selama lima tahun, tujuan kami adalah untuk mengkaji tantangan yang umum dihadapi dalam rekonstruksi flap bebas dan mengidentifikasi faktor-faktor yang berkontribusi pada kegagalan flap tersebut, dengan tujuan utama meningkatkan kurva pembelajaran kami.
Metode: Artikel ini menyajikan analisis retrospektif terhadap semua pasien yang menjalani prosedur transfer jaringan bebas mikrovaskular yang dilakukan oleh seorang operator bedah tunggal (PA) dan tim dari Residen Bedah Rekonstruktif dan Estetik Plastik dari tahun 2014 hingga 2018. Analisis multivariat dilakukan untuk mengidentifikasi faktor-faktor yang terkait dengan kegagalan flap bebas.
Hasil: Antara tahun 2014 dan 2018, total 203 transfer jaringan bebas mikrovaskular dilakukan untuk merekonstruksi defek di berbagai lokasi anatomi. Tingkat kelangsungan hidup flap yang berhasil secara keseluruhan untuk rekonstruksi flap bebas mikrovaskular, terlepas dari indikasi atau lokasi anatomi, terbukti mencapai 90,6%. Jenis flap, apakah itu flap perforator atau non-perforator, muncul sebagai faktor signifikan utama yang mempengaruhi kelangsungan hidup flap bebas.
Kesimpulan: Transfer jaringan bebas mikrovaskular merupakan pilihan rekonstruktif yang sangat baik untuk mengatasi defek besar yang memerlukan flap yang luas atau komposit. Dengan memahami faktor-faktor yang berkontribusi pada kegagalan flap bebas, kita dapat mengoptimalkan hasil dan memberikan hasil terbaik yang mungkin untuk pasien kita.

Kata Kunci: *Flap jaringan bebas, Bedah mikro, Kelangsungan hidup jaringan*

Conflicts of Interest Statement:
The author(s) listed in this manuscript declare the absence of any conflict of interest on the subject matter or materials discussed.

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INTRODUCTION

Microvascular free flap has emerged as the preferred treatment for complex reconstruction in a variety of conditions.[1] This procedure involves harvesting autologous tissue with its pedicle and transferring it to the site of the defect, requiring microsurgical vascular anastomosis to ensure its viability.[2-7]

Our center has been recognized as a leading referral center for advanced cases throughout Indonesia, including complex defects resulting from tumor removal or trauma that necessitate advanced techniques such as microvascular free flap closure. Although microvascular free tissue transfer has been documented clinically since the 1960s, its popularity in our center has grown significantly in the past five years.[7,8] Technological advancements and improvements in surgical techniques have led to higher flap viability rates and reduced perioperative complications. Consequently, extensive resection of pathological sites has become more feasible and widely practiced.[1-4,8]

Plastic surgery centers that perform microvascular free tissue transfer typically handle approximately 93-157 cases of free flap procedures over a span of four to nine years, with reported viability rates exceeding 89%.[8,10-14] Factors such as ASA classification and the need for re-exploration surgery have been identified as significant contributors to free flap failure.[8] In this study, our objective is to review our own approach to microvascular free flap procedures.

We will analyze patient characteristics and factors that are believed to influence free flap failure, aiming to enhance our learning curve and inspire aspiring plastic surgeons to engage in microsurgical practices.

METHOD

Study Design

This retrospective case series examines a total of 203 cases of microvascular free flaps. The analysis aims to identify patient characteristics and factors associated with free flap failure, including age, gender, Body Mass Index (BMI), defect location, flap type, disease entity, number of veins, vein graft usage, length of hospital stays, length of intensive care unit stays, and flap viability. Data were collected continuously from patients' medical records between January 2014 and December 2018.

Surgical Technique

The cases included in this study were performed by a single surgeon (PA) and a team of residents undergoing training in plastic reconstructive and aesthetic surgery. The surgeon primarily conducted the vascular anastomosis, while the closure of donor sites was performed by the residents. Heparin was administered to most patients either post-anastomosis or postoperatively, followed by close monitoring of flap viability through clinical examination and sound Doppler.

Data Assessment

Viable flaps were defined as those with less than 50% necrosis area, while non-viable flaps were those with more than 50% necrosis. The assessment of necrosis area was conducted through visual inspection. The Body Mass Index (BMI) classification used was adjusted according to the World Health Organization's (WHO) cutoffs specifically for the Asian population, which is considered more suitable for the subjects in this study[9]. Flap types were categorized into two groups: perforator flaps, including anterolateral thigh (ALT), deep inferior epigastric perforator (DIEP), and superficial circumflex iliac artery perforator (SCIP); and non-perforator flaps, including free fibular flap (FFF), proximal interphalangeal (PIP) flap, latissimus dorsi (LD) flap, vastus lateralis (VL) flap, and radial forearm free flap (RFFF). Other collected data in this study were sufficiently distinct and did not require specific operational definitions.

Statistical Analysis

The statistical analysis in this study utilized the Statistical Package for the Social Sciences (SPSS) version 20. Descriptive analysis was performed to summarize patients' characteristics. Bivariate analysis was then conducted for each characteristic, with flap viability as the dependent factor. Independent factors with a P-value < 0.20 were further analyzed using logistic regression to determine their impact on flap viability. The value of 0.20 exhibits a high degree of statistical significance and is the most proximate approximation to 0.05. A significance

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level of P-value < 0.20 was selected in order to incorporate additional variables into the multivariate analysis.

RESULTS

A total of 203 patients were included in the analysis, spanning from January 2014 to December 2019. The distribution of subjects was fairly equal between males and females (103 and 100 subjects, respectively), with the majority falling within the age range of 20-59 years. In terms of BMI, most patients were classified as underweight to normal, with BMI values ranging from 15.0 kg/m² to 26.8 kg/m² (Table 1).

Table 1. Description of subject characteristics

Subject characteristics	n (%)
Age in years (n = 202)	
<20 years	25 (12.4)
20-39 years	76 (37.6)
40-59 years	80 (39.6)
≥60 years	21 (10.4)
Gender (n = 203)	
Male	103 (50.7)
Female	100 (49.3)
BMI (n = 69)	
Underweight	20 (29.0)
Normal weight	39 (56.5)
Overweight	9 (13.0)
Obese	1 (1.4)
Location of defect (n = 202)	
Head and neck	166 (82.1)
Esophagus	1 (0.5)
Extremity	25 (12.4)
Trunk	5 (2.5)
Breast	5 (2.5)
Types of flap (n = 203)	
Perforator	103 (51.0)
Non-perforator	99 (49.0)
Disease entity (n = 197)	
Tumor	131 (66.5)
Infection	19 (9.6)
Trauma	42 (21.3)
Parry Romberg	1 (0.5)
Congenital	4 (2.0)
Number of veins (n = 196)	
1	107 (54.6)
2	87 (44.4)
3	2 (1.0)
Vein graft usage (n = 134)	
Yes	20 (14.9)
No	114 (85.1)
Length of hospital stay (n = 118)	11 (9.3)
<7 days	68 (57.6)
7-13 days	39 (33.1)
≥14 days	
Length of intensive unit stay (n = 88)	59 (67.0)
<3 days	29 (33.0)
≥3 days	
Viable flap	
Yes	183 (90.6)
No	19 (9.4)

The predominant cases encountered over the past five years were head and neck cases (81.8%), primarily caused by tumors (64.5%) and trauma (20.7%). Among the different types of free flaps utilized, the anterolateral thigh free flap was the most popular (47.3%), followed by the free fibular flap (29.6%) and radial forearm free flap (14.8%). Other types of free flaps, including the latissimus dorsi flap, deep inferior epigastric perforators flap, vastus lateralis flap, superficial circumflex iliac artery perforator flap, and proximal interphalanges flap, were less commonly performed, with each accounting for fewer than 10 cases during the five-year period.

The overall viability rate of microvascular free flaps in our center was 90.6% (n=183), with 9.4% of flaps classified as non-viable during follow-up. Single vein anastomosis was the predominant technique used, with vein grafting performed infrequently. Most patients were discharged from the hospital after 7-13 days of stay, and their treatment in the intensive care unit lasted less than 3 days.

Out of the ten independent factors analyzed, only one demonstrated a statistically significant independent association with free flap viability (P < 0.05). However, three other factors were found to be eligible for further analysis using a logistic regression model (P < 0.20), as described in Table 2. This study revealed that flap failure was associated with the number of veins anastomosed, BMI, length of hospital stays, and the type of flap chosen.

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Table 2. Factors linked to the viability of flaps

Predictors	Viable Flap		Total	P	RR (CI 95%)	P	aOR (CI 95%)
	Yes n (%)	No n (%)					
Number of veins	-	-	-	0.195[a)]	-	0.832	1.30 (0.11-14.83)
BMI	-	-	-	0.18[a)]	-	0.128	1.66 (0.87-3.18)
Length of hospital stay	-	-	-	0.073[a)]	-	0.095	0.92 (0.83-1.01)
Type of flap							
Perforator	89 (90.6)	14 (13.6)	103	0.038[a)]	0.37 (0.14-0.99)	0.259	
Non-perforator	94 (94.9)	5 (5.1)	99				0.10 (0.00-5.33)
Total	183 (90.6)	19 (9.4)	202				

[a)]Logistic Regression

The four selected predictors were subsequently analyzed using a logistic regression model. The findings indicated that the number of veins anastomosed, BMI, length of hospital stays, and type of flap accounted for 36.8% (Nagelkerke $R^2 = 0.368$) of the variability in flap viability. The remaining 63.2% was attributed to other factors not examined in this study. This conclusion was supported by a significant Hosmer and Lemeshow Test ($P > 0.05$), indicating good agreement between predicted and observed outcomes. Based on this analysis, an equation was derived to predict the probability of viable flaps with 97% accuracy. The equation is as follows:

Logit(viable flap) = -3.948 + 0.506 BMI + 0.263 NUMBER OF VEINS + 0.085 LENGTH OF HOSPITAL STAY – 2.275 TYPE OF FLAP

Furthermore, the trend of total free flap cases and their viability rate was observed year by year. The initial three years of practice showed a somewhat unstable trend. In 2015, the number of free flaps performed was higher, but the overall flap viability rate declined compared to the previous year. In contrast, 2016 saw a smaller number of total free flap cases, but a significant increase in the viability rate from 79.1% to 92.9%. The number of cases tended to stabilize in the last two years, with a slight decrease observed. In 2018, an increase in flap failure (from 7.5% to 9.7%) corresponded with.

DISCUSSION

Earlier studies conducted at a single center that reviewed the clinical experience of the microvascular free flap were compared to the current study (Table 3). To eliminate any technological bias, we focused on studies conducted in the past decade. These centre's reported viability rates ranging from 89.0% to 96.8%.[8,10-14] Even though the reviews from Thailand and Kenya, which had fewer microvascular free flap reconstructions (153 and 132 cases, respectively),[8,10] were most similar to ours, Thailand achieved a slightly higher success rate of 92.8%. This may be attributed to their extensive experience in microvascular free flap reconstruction. However, our study presents the largest dataset of microvascular free flap reconstructions from a single surgeon in Indonesia, with a follow-up period of up to five years.

Four separate studies conducted by a single surgeon, focusing on head and neck defect reconstructions, included varying numbers of treated cases. These studies demonstrated a positive trend in flap success rates, ranging from 92.0% to 96.8%.[11-14] Achieving consistently high success rates over several years in a specific area, such as head and neck reconstructions, suggests that repetition and a surgeon's familiarity with

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similar defects play a crucial role. This emphasizes the significance of the learning curve in achieving viable microvascular free flaps.[20-21] The figure presented in Figure 2 illustrates a sustained success rate above 90% in the past three years.

Table 3. Comparative analysis of flap viability rates among various studies

Author	Year	Number of flaps	Recipient site	Viability rate (%)
Present study	5-year	203	All area	90.6
Kamnerdnakta et al. (2015)[8]	5-year	153	All area	92.8
Nangole et al. (2015)[10]	5-year	132	All area	89.0
Pastars et al. (2018)[11]	8-year	157	Head and neck	96.8
Holom et al. (2012)[12]	9-year	143	Head and neck	92.0
Liang et al. (2018)[13]	8-year	93	Head and neck	90.3
Copelli et al. (2017)[14]	4-year	149	Head and neck	96.0

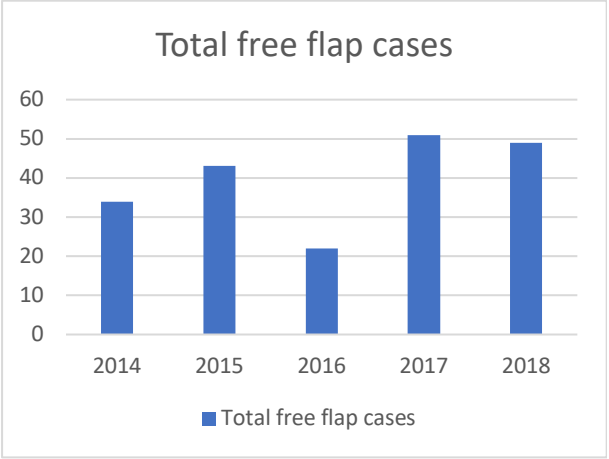

Figure 1. Number of cases involving free flaps over the previous five years

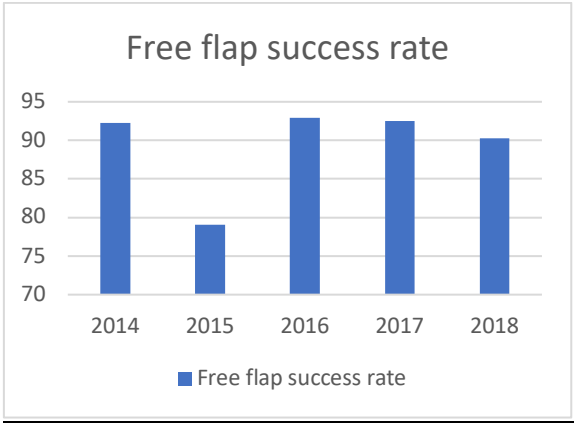

Figure 2. Flap viability rate observed over the previous five years

The statistically proven factors influencing microvascular free flap viability, such as the number of veins anastomosed, BMI, length of hospital stay, and type of flap, align with the findings of previous studies. Silverman et al.'s literature review demonstrated that the use of an internal jugular vein impacted the viability rate. However, in the context of head and neck defects, a single vein-free flap transfer is not expected to significantly affect flap viability due to gravity-related benefits.[19] Therefore, the choice of using one internal jugular vein or alternating between two veins can be considered. On the other hand, studies focused on lower extremity trauma highlight the importance of using dual veins instead of a single vein to improve flap viability. These studies indicate that dual-vein outflow can reduce flap failure rates by 69% and decrease complications fourfold.[16,17]

BMI, however, plays a distinct role in the success of microvascular free flaps. Previous research suggests that patients with lower BMI face a higher risk of recipient-site infection and facial fistula development.[18] These complications can adversely affect flap viability and patient morbidity.

Contrary to other factors, we believe that the length of hospital stay has a different influence on flap viability. It is more of a consequence of undesired flap outcomes rather than a predictor of viability. Previous studies have shown longer hospitalization periods ranging from 20.5 to 36.6 days.[8,11-13] Interestingly, studies with extended hospital stays often reported higher success rates, possibly due to a higher rate of re-exploration and salvaging surgeries. Unfortunately, our study did not analyze data related to re-

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exploration and salvaging surgeries, which calls for further investigation.

We acknowledge several limitations that may impact the conclusions of our study. Flap viability determination relied on subjective physical examinations, introducing potential bias. To mitigate this, we involved multiple interpreters for flap measurements. Future studies should employ objective measures. Additionally, inadequate documentation in our medical records led to the unavailability of specific data for some patients.

CONCLUSION

Performing a total of 203 microvascular free flaps within a four-year period by a single surgeon in a developing country is a noteworthy achievement. In order to maintain a consistently high success rate, it is essential to continuously assess the factors that influence flap viability. This study revealed that the number of veins anastomosed, BMI, length of hospital stay, and flap type all play a role in determining the viability of the flap. As a result, the surgeon has successfully navigated the learning curve associated with these factors.

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