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Original Research Article

Outcomes of free flap reconstructive surgery in cancer patients-institutional experience

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ABSTRACT

Background: The success rate of free flap reconstruction following cancer surgery has steadily improved over past decades and has achieved a success rate of 91–99%, but occasional failures still occur. The aim of this study was to identify the outcomes of free flap reconstructions in our institution. The primary objective was to assess the success rates of free tissue transfer. The second objective was to assess independent preoperative, intra-operative, and postoperative risk factors for flap loss after microvascular reconstruction.
Methods: All consecutive cancer patients who received a free flap for head and neck, appendicular bone, perineal, and extremity reconstruction between October 2020 and September 2023 in our institute were included. Patient characteristics, surgical data, postoperative complications, and reoperations were collected.
Results: A total of 37 patients who underwent reconstruction by free flaps were analysed. The overall flap success rate was 73%. Among 37 patients, 12 (32.4%) had flap complications and 10 (27%) had flap loss. Smoking, comorbidity, and operating time did not show significant association with flap failure whereas the choice of flap, reconstruction post radiation, and reconstruction for recurrent cancers showed significant association with flap loss.
Conclusion: The overall success rate of 73% in free flap reconstructive surgery in our study mandates us to modify our treatment policy by careful patient selection, better choice of free flap, improved treatment algorithm in terms of flap monitoring and timing of re-exploration, which will help in reduction of free flap failure rates.

Keywords: Free flap, Reconstructive surgery, Free tissue transfer, Radial forearm flap, Outcomes of free flap, Complications of free flap, Microsurgery

INTRODUCTION

Microvascular free flap reconstruction has been regarded as a standard procedure following complex cancer resections, especially head and neck cancer. Its technique has progressed well over time and the success rate of free tissue transfer has steadily improved over past decades.[1] With a success rate of 91–99%, occasional failures still do occur.[2] Accurate surgical technique is the most important factor in achieving high success rates. Even in experienced hands, partial or total flap failure remains a true possibility, which is a dramatic event for both patient and surgeon, leading to additional surgery, hospitalization, increased costs, and emotional stress.[3] It seems therefore important to know which factors lead to an increased risk of flap failure, so that measures can be undertaken to reduce this risk and to improve patient selection. Several variables have been demonstrated to be associated with flap loss after free tissue transfer. Reported preoperative risk factors are age, gender, tobacco use, diabetes, hypertension, higher BMI, prior radiotherapy, and recipient-site surgery. Intra-operative

risk factors are limited surgical experience, use of vascular interposition grafts, and choice of free flap. Among postoperative risk factors, re-exploration with or without revision of an anastomosis has been associated with higher flap loss rates. The aim of this study was to identify the outcomes of free flap reconstructions in our institution. The primary objective was to assess the success rates of free tissue transfer. The second objective was to assess independent preoperative, intra-operative, and postoperative risk factors for flap loss after microvascular reconstruction.

METHODS

Study design

Patients who received a free flap for head and neck, appendicular bone, perineal, and extremity reconstruction between October 2020 and September 2023 at Department of Surgical Oncology, Government Royapettah Hospital, Chennai were included in this prospective observational study. Being an observational study, all consecutive cancer patients with free flap surgeries were included in the study with no exclusion criteria and no target sample size. Ethical approval was obtained from Institutional Ethics committee

Data collection

Patient characteristics, surgical data, postoperative complications, and reoperations were collected. Preoperative characteristics were sex, age, BMI, tobacco use, comorbidities, medication, free flap indication and location, prior recipient-site surgery, and previous chemotherapy and radiotherapy.

Intraoperative characteristics included flap type, total operative time, recipient vessels, number of anastomoses, use of vein grafts, and intra-operative revision of anastomosis. Postoperative characteristics included postoperative complications leading to re-operation such as haematoma, infection, signs of compromised flap circulation, and flap loss. The duration of postoperative hospital stay was also analysed.

Statistical analysis

Data analysis was done using SPSS version 24. Descriptive statistics including mean and standard deviations were calculated for quantitative variables, and frequencies and percentages for qualitative variables. Chi square and Fisher's exact test were used for bivariate analysis in case of categorical data. Unpaired student's T test and ANOVA were used for comparing continuous data.

RESULTS

A total of 37 patients who underwent reconstruction by free flaps were analysed.

Age and sex distribution

The mean±SD age of the study participants was found to be 52.76±12.83 years. The median (IQR) age was 55 (47.50-59) years. The minimum and maximum ages were found to be 12 and 75 years respectively with a range of 63 years. Among 37 study participants, 30 (81.1%) were males and the remaining 7 (18.9%) were females.

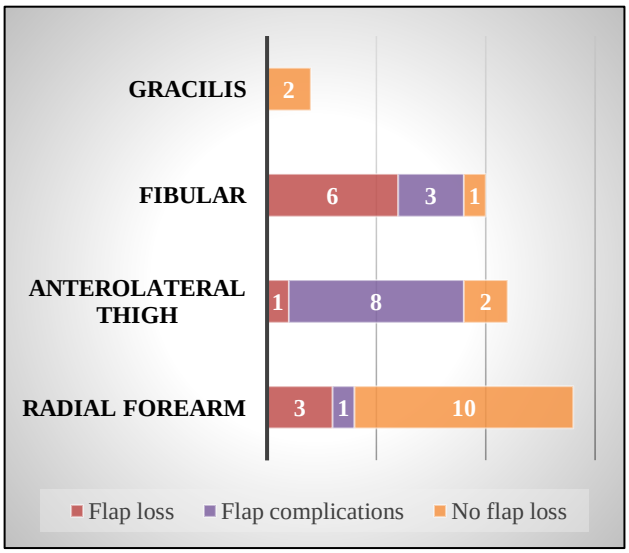

Figure 1: Flap loss and complications among different types of flaps.

Site of cancer

Head and neck cancers, predominantly oral cancers (81.1%) were the most common primary site for which free flap reconstruction was performed. The other sites were maxilla, humerus, melanoma of foot, and vulva (Table 1).

Table 1: Primary cancer sites.

Primary site	Number	%
Oral cavity	30	81.1
Maxilla	2	5.4
Humerus-bone tumour	2	5.4
Melanoma of foot	2	5.4
Vulva	1	2.7

Free flap types and microvascular anastomosis

The most common flap used was the radial forearm flap, accounting for 37.8% of the cases. The anterolateral thigh (ALT) flap was the second most frequently employed, with 29.8%. The fibular flap was used in 27% of cases. The gracilis flap had a much lower utilization at 5.2%. Regarding the number of anastomoses, a significant majority (81.1%) had two anastomoses, and the remaining 18.9% had three anastomoses (two vein and one artery).

Table 2: Types of free flaps and number of anastomoses.

Flap		Number	%
Radial forearm		14	37.8
Anterolateral thigh		11	29.8
Fibular		10	27.0
Gracilis		2	5.2
Number of anastomoses	2	30	81.1
	3	7	18.9

Patient characteristics

Many patients were smokers, with 64.9% reporting smoking habits, while 35.1% were non-smokers. In terms of co-morbidities, 30.8% of the patients had co-morbid conditions, whereas the majority, 69.2%, did not report any co-existing health issues.

Most of the co-morbidities were diabetes and/or hypertension. 21.6% patients were smokers with co-morbid conditions. These data are represented in Table 3.

Table 3: Patient characteristics.

Patient characteristics		Number	%
Smoking	Yes	24	64.9
	No	13	35.1
Co-morbidity	Present	11	30.8
	Absent	26	69.2
Smokers with co-morbidity	Present	8	21.6
	Absent	29	78.4

Characteristics of head and neck cancer patients

Among the 32 head and neck cancer patients, 12.5% of the patients were operated for residue post definitive chemoradiation and the rest were operated upfront (87.5%). Four patients were operated for recurrent cancer (Table 4).

Table 4: Characteristics of head and neck cancer patients.

Cancer characteristics		Number	%
Surgery	Upfront/primary	4	12.5
	Salvage	28	87.5
Cancer	Primary	28	87.5
	Recurrent	4	12.5

Operation time and length of hospital stay

The operation time, measured in hours, had an average of 10.03 hours with a standard deviation of 1.12. The median operation time was 10 hours, falling within an interquartile range (IQR) of 9 to 11 hours. The operation time ranged from a minimum of 8 hours to a maximum of 12 hours.

Concerning the length of hospital stay, measured in days, the mean duration was 24.71 days with a standard deviation of 18.57. The median length of hospital stay was 17 days, within an IQR of 12 to 29 days. The length of hospital stays varied from a minimum of 7 days to a maximum of 65 days (Table 5).

Table 5: Operation time and length of hospital stay.

Variable		Values
Operation time in hours	Mean±SD	10.03±1.12
	Median (IQR)	10 (9-11)
	(minimum, maximum)	(8, 12)
Length of hospital stay in days	Mean ± SD	24.71±18.57
	Median (IQR)	17 (12-29)
	(minimum, maximum)	(7, 65)

Flap survival/loss

The overall flap success rate was 73%. Among 37 patients, flap loss, either partial or complete, was observed in 22 (59.5%) patients. Among these, 12(32.4%) had flap complications and 10 (27%) had flap loss.The distribution of flap loss and complications among different free flap reconstructions is depicted in Figure 1. The data reveals that the radial forearm flap had a flap loss in 21.4% of cases, with flap complications occurring in 7.1% of instances, and no flap loss in most cases at 71.4%.

For the anterolateral thigh flap, flap complications were observed in 72.7% of cases, with only 9.1% experiencing flap loss and 18.2% showing no flap loss. Fibular flaps had a relatively high flap loss rate at 60%, with 30% experiencing flap complications and 10% with no flap loss. The gracilis flaps showed no instances of flap loss. This Chi-square test demonstrates the significant association (p=0.003) between flap type and flap loss (Table 6).

Flap complications including loss and patient/tumour characteristics

The association between flap complications and patient/tumour characteristics are given in table 7 and 8. Firstly, in terms of smoking, the table shows that flap complications was observed in 62.5% of patients who were smokers, while 53.8% of non-smokers experienced flap complications. A chi-square test was conducted, resulting in a p value of 0.609, indicating that there was no statistically significant association between smoking and flap complications (X2=0.262).

Secondly, the presence of co-morbidities was analysed. Among patients with co-morbidities, 63.6% experienced flap complications, and 26.4% did not. In the absence of co-morbidities, 50% of patients had flap complications. The chi-square test yielded a p value of 0.503, suggesting that co-morbidity was not significantly associated with

flap complications (X2=0.449). Lastly, the type of cancer and type of surgery was considered. Flap complications occurred in 54.5% of patients with primary cancer and 100% of patients with recurrent cancer. There was a statistically significant difference with a p value of 0.040. Flap complications occurred in 57.5% of patients with primary surgery and 75% of patients with salvage surgery. There was a statistically significant difference with a p value of 0.049.

Table 6: Association between flap loss and different types of flaps.

Flap	Flap loss	Flap complications	No flap loss	X2	P value^
Radial forearm	3 (21.4)	1 (7.1)	10 (71.4)	23.666	0.003*
Anterolateral thigh	1 (9.1)	8 (72.7)	2 (18.2)		
Fibular	6 (60)	3 (30)	1 (10)		
Gracilis	0 (0)	0 (0)	2 (100)		

*Significant p value; ^ Chi-square test.

Table 7: Association between flap loss and patient/tumour characteristics.

Patient characteristics		Flap complications including loss		X2	P value
		Present N (%)	Absent N (%)		
Smoking	Present	15 (62.5)	9 (37.5)	0.262	0.609^
	Absent	7 (53.8)	6 (46.2)		
Co-morbidity	Present	7 (63.6)	4 (26.4)	0.449	0.503^
	Absent	13 (50)	13 (50)		
Type of cancer	Primary	18 (54.5)	15 (45.5)	NA	0.040*^^
	Recurrent	4 (100)	0 (0)		
Type of surgery	Primary	19 (57.5)	14 (42.5)	NA	0.049*^^
	Salvage	3 (75)	1(25)		

*Significant p value; ^ Chi-square test; ^^ Fisher's exact test, NA not available.

Table 8: Association between flap loss/complications and patient/tumour characteristics.

Patient characteristics		Flap loss	Flap complications	No flap loss	X2	P value^
Smoking	Present	7 (29.2)	8 (33.3)	9 (37.5)	0.289	0.866
	Absent	3 (23.1)	4 (30.8)	6 (37.5)		
Co-morbidity	Present	4 (36.3)	3 (27.4)	4 (36.3)	0.701	0.704
	Absent	6 (23.1)	7 (26.9)	13 (50)		
Type of cancer	Primary	8 (24.2)	10 (30.3)	15 (45.5)	3.121	0.210
	Recurrent	2 (50)	2 (50)	0 (0)		
Type of surgery	Primary	11 (33.3)	8(24.2)	14 (42.5)	NA	0.310
	Salvage	2 (50)	1(25)	1(25)		

*Significant p value; ^ Chi-square test.

Table 9: Association between flap loss with operation time and length of hospital stay.

Variable		Flap loss	Flap complications	No flap loss	P value^
Operation time in hours	Mean±SD	10.60±1.17	9.75±1.22	9.87±0.92	0.160
	Median (IQR)	10.50 (9.75-12)	10 (9-10.75)	10 (10-10)	
Length of hospital stay in days	Mean±SD	43.17±18.77	27.20±18.75	12.40±3.95	0.001*
	Median (IQR)	41 (26.50-62.75)	20 (15.5-42.50)	12 (9-15.5)	

*Significant p value; ^ANOVA.

Flap loss and operation time/length of hospital stay

Table 9 provides insight into the relationship between flap loss/complications and two variables: operation time and length of hospital stay. On average, the operation time for cases with flap loss was 10.60 hours, with 9.75 hours for flap complications, and 9.87 hours for no flap loss. However, statistical analysis (ANOVA) did not indicate a significant association between operation time and flap loss (p=0.160).

DISCUSSION

Microsurgical free tissue transfer has been performed in our institution for cancer patients for the past three years. On comparing many similar retrospective clinical studies in the literature, the overall success rate of 73% is an intriguing finding and deserves explanation.[4-6] Majority of our reconstructions were for head and neck cancer (86.5%). The radial forearm flap was the most commonly used free flap in head and neck reconstructions followed by anterolateral thigh flap (ALT). The use of these flaps resulted in a lower chance of flap failure with combined overall success rate of 85.5%. ALT flap reconstruction had a good success rate of almost 91%.

However, the outcomes were poor for fibular free flap with 60% failure rate. This might be due to combined patient and surgeon factors taking into consideration, the learning curve as described by Chaine et al.[7] According to Eckardt et al, conventional free flaps like radial forearm flap and anterolateral thigh flaps maintained a significant better flap survival rate in reconstruction of oral defects.[8] Because of its high vascularity, thin pliable tissue, and reliable anatomy, this free flap is easy to dissect and its long and large calibre vessels obviate the need for vein grafts.

Flap loss generally occurs after failure of the anastomosis, which should ideally be a relatively rare event, whereas flap complications are usually the result of an insufficient flap microcirculation. This can occur after inclusion of a too large skin paddle, failure to treat intra-operative venous congestion with an additional venous anastomosis, or failure to select the dominant perforator(s). Intraoperative revision of the venous anastomosis can also increase the risk of flap failure. This increases the ischaemia time, which could lead to post ischaemia reperfusion injury and, consequently, to partial or total necrosis.

Moreover, intraoperative vascular problems are associated with postoperative venous thrombosis, which could lead to flap loss, as was previously found by Seo et al.[9] Operative time, especially those exceeding 10 hours was not associated with a significant higher risk of flap loss in our study. Prolonged anaesthesia time was previously found to double the risk of flap failure.[10] This is likely a reflection of increased intraoperative difficulties, such as difficult recipient-site, vessel dissection, the need for venous interposition grafts, or revision of an anastomosis. Postoperative signs of compromised flap circulation were a significant risk factor for flap loss. Las et al studied postoperative complications in 1500 free flaps and concluded that the timing of re-exploration of compromised flaps has a significant effect on flap salvage rates.[11] In our series approximately 60% of the compromised flaps were salvaged after re-operation.

This suggests an active flap monitoring protocol needs to be established to pick up early signs of compromised flap circulation such as arterial ischemia or venous congestion. We should be proactive in re-exploration of compromised flaps, to see whether there is a treatable cause, such as microvascular thrombosis or kinking of the pedicle.[12] If no cause can be found, it probably is an intrinsic vascularization problem of the flap and even in case of early exploration, flap failure may be inevitable.[13]

Patients with tobacco use (smoking) and/or comorbidity (diabetes/hypertension) showed a higher risk of flap loss in our study, although not found statistically significant. Each of them is a potential independent risk factor for partial flap loss. Assuming that each is a confounding factor, a multivariate regression analysis will throw more light into these factors. Smoking elevates platelet count increasing the risk of thrombosis, activates the sympathetic nervous system causing vasoconstriction, and causes hypoxia due to binding of carbon monoxide to haemoglobin. All three pathways could compromise flap circulation.[14,15] Another reason could be the lower oxygen saturation levels in coexisting COPD patients, caused by exacerbation or airway infections, leading to a decreased oxygenation of the flap which in turn could result in partial flap failure.

There is controversy about whether preoperative radiotherapy increases chances of flap failure. In our study, four patients of salvage surgery after radiation had flap loss and only one flap survived after a complication. These results corroborate the findings of other studies which showed a significant relationship between preoperative radiotherapy and an increased risk of flap failure, specifically in delayed reconstructions and if the total dose exceeded 60 Gy.[16,17] Choosing the recipient vessels outside the radiated field, such as from the contralateral neck could help to reduce the chance of postoperative microsurgical complications.[18]

Furthermore, the learning curve of microsurgeons, all in a different point of their learning curve might have influenced the results, especially during the first year of the current series when free flaps were performed with presumably limited microsurgical experience. The existence of a learning curve in microsurgeons has been shown several times in older studies.[19,20] Therefore, we assume the relationship between surgeon experience and flap failure might have been present only in the first year of the present series. Variables that could have been influenced by limited microsurgical experience are flap choice, recipient vessel choice and total anaesthesia time. Finally, the increase of microsurgical experience during the later years could be the reason for lower flap failures rates in the subsequent years of our study. However, if we look at the percentage of fibular free flap failure over the study period, there has not been a large change in flap failure rates. This suggests that we need to step up our strategy in this domain.

CONCLUSION

The overall success rate of 73% in free flap reconstructive surgery in our study mandates us to modify our treatment policy by careful patient selection, better choice of free flap, improved treatment algorithm in terms of flap monitoring and timing of re-exploration, which will help in reduction of free flap failure rates. Considering that surgical technique is the most important factor, there is scope for improvement in microsurgical training and clinical expertise.

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