International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 14, No. 1, January 2025 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_14.1.2025.92

ORIGINAL RESEARCH

A Study of Microvascular Reconstruction of Oral and Maxillo-facial Defects

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Received: 29 December, 2024 Accepted: 15 January, 2025 Published: 30 January, 2025

ABSTRACT
The study, titled "A Study of Microvascular Reconstruction of Oral and Maxillo-facial Defects" aims to fill the gap in region-specific data on head and neck reconstruction using free flaps in India. Free flaps are currently the gold standard for reconstruction of head and neck defects after ablative oncosurgery. They have significantly improved patient outcomes especially when the defects are three dimensional and extensive. The aim of this 5-year retrospective study is to analyze the outcomes of free tissue transfers in the head and neck area in the Department of Plastic and Reconstructive Surgery of a tertiary care hospital in North India, from March 2019 to September 2024. Patient demographics, comorbidities, flap characteristics, outcomes and complications were assessed. A total of 42 free flaps were performed after oncologic resection. The Radial Artery Forearm free flap was the most commonly used flap followed by Antero-lateral thigh flap. Our overall flap success rate was 95%, while the overall complication rate was 17%. Free tissue transfer in head and neck reconstruction is reliable and with meticulous surgical technique and competent anaesthesia care, the complication rates remain low. Adjunctive treatments like radiation and chemotherapy can also be given alongside without affecting flap survival.
Keywords: free flaps; head and neck reconstruction

INTRODUCTION

Reconstruction of complex head and neck defects by means of free tissue transfer is the gold standard in defect coverage after performing extensive oncologic resections [**1**,**2**]. Very large defects with multiple tissue components in three dimensions can now be reconstructed with almost complete restoration of form and function. Micro-vascular free tissue transfer addresses the need for soft tissue coverage of underlying structures such as bone, major vessels and nerves as well as the need for separation of them from non-sterile areas such as the oral and nasal cavity by reconstructing anatomical barriers [**2**], obliteration of dead space with well-vascularized tissue, reconstruction of bone defects while maintaining an acceptable functional result in terms of airway clearance and unhindered breathing, as well as oral competence and oral food intake. Last but not least, a high regard for an adequate aesthetic result should be kept, as such reconstructions concern a rather visible portion of the human body.

With advances in the fields of Anaesthesia, Radiotherapy and Chemotherapy, larger tumours can now be resected safely and hence the size and depth of defects presented to the reconstructive surgeon has undergone an enhancement in the last few decades. It becomes obvious that conventional reconstructive approaches by means of local pedicled flaps represent a second line of reconstruction for major tissue defects after oncologic surgery. Such flaps may not be always able to provide tissue of sufficient quantity and/or quality and their harvesting may also be impaired due to previous surgery or radiotherapy in their donor region. Regional flaps, such as the pedicledlatissimusdorsi flap, should not be fully disregarded, as they can still be valuable options when patients would not qualify for free tissue transfer,

DOI: 10.69605/ijlbpr_14.1.2025.92

especially when adequate recipient vessels are not available [**2**].

Various workhorse flaps have opened up an exciting new world for the reconstructive surgeon. Radial forearm free flap, Anterolateral thigh flap, Fibula osteo-septo-cutaneous free flap, Lattisimusdorsi free flap, Gracilis free flap etc. have differing tissue characteristics and are a varied palette to choose from, depending on the characteristics of the defect and the tissue that needs reconstruction or the function that needs to be restored. Double- barrelled flaps and combination flaps can also be used for 3-D defects in which the internal as well as the external lining needs to be restored. Such a choice also takes into account the requirements of tissue volume, texture and pedicle length.

Free microvascular tissue transfer has become the first option for any reconstruction now, in capable hands. The reliability of commonly used flaps can be predictable for an experienced reconstructive surgeon. However, the heterogeneous patient-related characteristics in the head and neck region can entail confounding factors that may interfere with postoperative complications and affect outcome [**3**,**4**]. A better understanding of the association between various patient-related factors and postoperative complications is thus necessary in order to be able to better counsel the patients preoperatively and possibly refine reconstructive techniques. Therefore, the aim of this study is to analyze the reconstruction outcomes after free tissue transfers in the head and neck region over a 5-year period in a tertiary care centre.

REVIEW OF LITERATURE

The aim of reconstruction after resection of head and neck tumors is to achieve acceptable functional and aesthetic results with minimal donor site morbidity. Although many flaps have been developed for bone and soft tissue reconstructions, experience in the past years has identified the anterolateral thigh flap, the radial forearm flap, and the osteo-septo-cutaneous fibula flap as the most useful flaps for head and neck reconstruction. (1) Local and pedicled flaps are available for head and neck reconstruction, but they have increasingly been found to be inadequate for large and complex defects. Free flaps provide superior functional and aesthetic restoration with less donor-site morbidity. (2)Although complication rates are high, but this is mitigated by the high flap survival rates. Wound healing and infectious complications account for most complications in patients with head and neck cancer undergoing free flap reconstruction. (4)The time of presentation of flap compromise is a significant predictor of flap salvage outcome. Intensive flap monitoring at a special microsurgical intensive care unit by well-trained nurses and surgeons allows for early detection of vascular compromise, and early intervention, which leads to better outcomes.(5)Defect aetiology , presence of coronary heart disease, diabetes, smoking, peripheral arterial vascular disease, arterial hypertension and American Society of Anesthesiologists (ASA) classification have been found to be predictors of complications in free tissue transfer.(6)To improve flap survival, anticoagulation can be considered in cases of small vessels, significant size mismatch, vein graft, or vessels of poor quality. Monitoring should be done hourly during the first 24 hours and then every 4 hours for the next 2 postoperative days.(7) The overall complication rate has been found to be high, upto 50% in many studies, those requiring surgical intervention can go upto 20%. Aetiology, patient age, smoking history and the presence of comorbid conditions are related to higher rates of major and minor complications.(8)The incidence of diabetes mellitus in patients with failed free flaps is 2.3 times higher than in the general population. (9) Insulin-dependent diabetes, operative time, age, white blood cell (WBC) count, and smoking correlate with overall complications and serious complications like return to the operating room, pneumonia, deep surgical site infection, sepsis, and unplanned intubation. Operative time, clean contaminated wound status, dirty wound classification, and history of congestive heart failure are predictive of flap survival and complications. (10)

AIMS AND OBJECTIVES

1. To study the types of free micro-vascular free tissue transfer used for reconstruction of various sites of onco-surgical head and neck defects
2. To analyze flap survival and pattern of complications

MATERIALS AND METHODS

This retrospective study included all patients from March 2019 to September 2024 who underwent free tissue transfer for reconstruction of oncosurgicaldefects in the head and neck region in a tertiary care hospital in North India. Patients of oncosurgical resection who underwent reconstruction with local or pedicled flaps were not included in the study. The following patient-related data were collected: patient age at the time of surgery, gender, comorbidities such as regular tobacco or alcohol consumption, body mass index and presence of obesity, American Society of Anesthesiologists (ASA) score [**5**], diabetes, high blood pressure, heart failure/coronary disease, cerebrovascular disease, coagulation disorders, peripheral arterial occlusive disease and chronic obstructive pulmonary disease. The aetiology of the defect, the anatomic location of defect, involvement of bone in the defect, flap used for reconstruction, the donor vessels used for anastomosis, vascular compromise of flaps and flap failure, and postoperative minor and major complications, including those of the donor and recipient site were also assessed. Complications were classified as major when their management required a surgical intervention. The complications assessed

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were flap congestion, flap failure, wound dehiscence, wound infection and delayed healing of donor site. The minimum follow-up period was 2 months. The data was assessed using standard statistical methods.

Operative Photographs

Fig. 1 Large defect of left cheek created after wide excision of invasive tumour of left buccal mucosa

Fig. 2 Harvest of fascio-cutaneous Radial Artery Free Forearm Flap from the left forearm

Fig. 3 Insetting of double-barreled Radial Artery Free Forearm Flap into the left cheek and buccal mucosa defect

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OBSERVATIONS

42 patients undergoing onco-surgical resection for malignant tumours of head and neck, and subsequent reconstruction with microvascular free tissue transfer were included in the study. 35 of these patients were male and 7 were female. 4 patients were in the 25-40 years age group, 15 patients were 40-50 years of age, 14 patients were 50-60 years of age and 9 patients were more than 60 years of age.

Table 1- Most common risk factors and comorbidities of patients

S.no.	Comorbidity	No. of Cases
1	Smoking	24
2	Tobacco Consumption	17
3	Alchohol Consumption	14
4	Hypertension	11
5	Pulmonary Disease	4
6	Diabetes Mellitus	2
7	Coronary Artery Disease	1

Table 1 shows the distribution of risk factors and comorbidities in our patients. 24 patients (57%) patients were chronic smokers, 17 patients (40%) had a history of chronic tobacco use, 14 patients (33%) were chronic alchoholics, 11 patients (26%) had a history of hypertension, 4 patients (9%) had chronic pulmonary disease, 2 patients (5%) had Diabetes Mellitus and 1 patient was a known case of Coronary Artery Disease.

Table 2 – Distribution of Sites of Primary Tumour

S.no.	Site of Primary Tumour	No. of cases
1	SCC Buccal mucosa	20
2	SCCCheek	6
3	SCC Tongue	5
4	SCC Alveolus	4
5	SCC Hard Palate	2
6	SCC Lower eyelid	1
7	Nodal mass in neck	1
8	Giant Cell Tumour of mandible	1
9	SCC Larynx	1
10	SCC Angle of Mouth	1

Table 2 shows the distribution of sites of primary tumour. The most common site of primary tumour was buccal mucosa as seen in 20 patients (48%). 6 patients had cheek tumours (14%), most probably, a primary of buccal mucosa invading skin and subcutaneous tissue. 5 patients(12%) had tongue tumours, 4 patients (10%) had tumours of the alveolus, 2 patients (5%) had hard palate tumours, and 1 patient each (2%) had tumours of lower eyelid, larynx and angle of mouth. 1 patient had a giant cell tumour of mandible and 1 patient had a recurrent nodal mass in the neck. The most common histology of primary tumours was Squamous Cell Carcinoma pervading 41 out of 42 patients (98%).

Table 3 – Types of Microvascular Free Tissue Transfer used for Reconstruction of Defects

S. no.	Type of Free Tissue Transfer	No. of Cases
1	Radial Artery Free Forearm Flap (RAFF)	30
2	Antero-lateral Thigh Flap (ALT)	8
3	Free Fibula Osteo-septo-cutaneous Flap	4

Table 3 shows the type of micro-vascular free tissue transfer done for the reconstruction of 3-dimensional defects created by the Wide Excision of the Primary Tumour. The most common flap utilized was Radial Artery based Free Forearm Flap, which was done in 30 patients (71%). 8 patients, in which the defects were more extensive, were reconstructed using Antero-lateral Thigh Flaps (19%). Free Fibula Osteo-septo-cutaneous Flaps were used for the reconstruction of mandibular defects in 4 patients (10%).

Table 4 – Donor Artery used for Anastomosis with Recipient Artery from Free Flap

S. no.	Donor Artery used for Anastomosis	No. of Cases
1	Facial Artery	39
2	Lingual Artery	1

DOI: 10.69605/ijlbpr_14.1.2025.92

3	Superficial Temporal Artery	1
4	Transverse Cervical Artery	1

Table 4 shows the various types of donor arteries used for anastomosis with the recipient artery (Radial artery, descending branch of Lateral Circumflex Femoral artery or Peroneal artery) from the free flap. In almost all the neck dissections, Facial artery was spared and was thus available for anastomosis (39 out of 42, 93% patients). In 3 patients, Facial artery also had to be sacrificed during neck dissection. In 1 each of these patients (2%), Lingual artery, Superficial Temporal artery and Transverse Cervical artery were utilized.

Table 5 – Donor Vein used for Anastomosis with Recipient Vein from Free Flap

S. no.	Donor Vein used for Anastomosis	No. of Cases
1	External Jugular Vein and Internal Jugular Vein	15
2	External Jugular Vein	11
3	Common Facial Vein	10
4	Internal Jugular Vein	4
5	Superficial Temporal Vein	1
6	Anterior Jugular Vein	1

Table 5 shows the various types of donor veins used for anastomosis with recipient vein (Cephalic vein, venae comitantes of Radial artery, descending branch of Lateral Circumflex Femoral artery or Peroneal artery) from free flap. In 15 patients (36%), both External Jugular Vein and Internal Jugular Vein were used for anastomosis with Cephalic Vein and Vena Comitans of Radial Artery. In 11 patients (26%), only External Jugular Vein was used. Hence External Jugular Vein was the most commonly used vein (26 patients, 62% cases). In 10 patients (24%), Common Facial Vein was used, in 4 patients (10%), only Internal Jugular Vein was used, and in 1 patient each (2% each), Superficial Temporal Vein and Anterior Jugular Vein were used.

Table 6 – Complications of Microvascular Free Tissue Reconstruction for Head and Neck Defects

S. no.	Complication	No. of Cases
1	Flap Congestion requiring Flap Re-exploration	6
2	Complete necrosis of free flap	3
3	Partial necrosis of free flap	2
4	Wound Dehiscence	1
5	Wound Infection	1
6	Donor site –delayed healing	2

Table 6 shows the various complications encountered after microvascular free tissue transfer for oncosurgical head and neck defefcts. Flap congestion requiring re-exploration of the arterial and venous anastomosis was observed in 6 patients (14%).. 5 of these flaps were re-explored in the emergency. Kinking of vessels was corrected in 2 patients and re-anastomosis of the vein was done in 3 patients. 3 of these flaps could be salvaged. In 2 of the re-explored flaps, vascular re-anastomosis was not successful in correcting the vascular compromise. These 2 flaps (1 Anterolateral Thigh Flap and 1 Free Fibula Osteo-septo-cutaneous Flap) underwent complete necrosis (5%) and the patients subsequently had to undergo secondary reconstruction. 1 patient developed systemic complications of COVID after Free Fibula transfer, developed thrombotic necrosis of the flap and subsequently died due to COVID related multi-organ failure.

Partial necrosis of 2 flaps was observed (5%), both were Radial Artery Free Forearm flaps. No surgical intervention was required and the flap healed on its own without functional compromise. Wound dehiscence and wound infection were seen in 1 patient each (2%) and resolved without the need for re-suturing.

Delayed healing of the donor site was seen in 2 cases (5%). 1 patient had partial graft loss at the forearm donor site of Radial Artery Forearm Free Flap and 1 patient had wound dehiscence at the thigh donor site of Antero-lateral Thigh Flap. Both of these healed with regular dressing changes and no surgical intervention was needed.

DISCUSSION

Free tissue transfer is a reliable reconstructive method for defects in the head and neck area with high success rates, despite frequent complications. Our study had an overall flap survival rate of 95% and an overall complication rate of 17% which is consistent with the rates observed by Bianchi et al. and Cannady et al. There was a statistically significant prevalence of smoking among the patients, to the tune of 57% which directly correlates with the carcinogenic effect

DOI: 10.69605/ijlbpr_14.1.2025.92

of tobacco smoke. The overall complication rate was also higher among smokers, almost 60% of smokers undergoing tumour resection and micro-vascular free flap reconstruction had flap or donor site complications. 2 of the 3 patients undergoing total flap necrosis were also smokers. Smoking is known to adversely influence flap survival due to its short term vasoconstriction effect and long term atherosclerotic changes.

35 out of 42 patients undergoing onco-surgical resection for malignant tumours of head and neck, and subsequent reconstruction with microvascular free tissue transfer, were male and 7 were female. This correlates well with the higher prevalence of oral malignancy in the male population stemming from a larger base of smokers and tobacco users. Most of the patients were more than 50 years of age but there was a substantial chunk in the 40-50 year age group indicating an increasing trend of involvement of lesser age groups.The most common histology of primary tumours was Squamous Cell Carcinoma pervading 41 out of 42 patients (98%).The most common site of primary tumour was buccalmucosa which is similar to the finding by Lutz et al.

In our study, the most common flap utilized was Radial Artery based Free Forearm Flap, which was done in 30 patients (71%). This is attributed to the tissue characteristics of this flap. It has a supple texture and gives better colour match for facial defects, provided they are not too extensive. Other studies by Wong et al. and Eskander et al. report Antero-lateral Thigh Flap as the most commonly used flap. The tumours in our study might have been diagnosed earlier and hence the defect sizes were smaller. When the defects are more extensive, they can be reconstructed using Antero-lateral Thigh Flaps or free Lattisimusdorsi flaps which conveniently supply larger volume of tissue for filling up three-dimensional defects.. Free Fibula Osteo-septo-cutaneous Flaps are reserved for the reconstruction of mandible defects where the dento-skeletal framework is disrupted.

Facial artery was the most commonly used donor vessel. In most neck dissections, it was spared and was thus available for anastomosis (39 out of 42, 93% patients). Facial artery is a long branch of External Carotid artery and has an adequate caliber which matches the caliber of all the recipient arteries. Venous anastomosis was done in an end-to-end fashion when External Jugular Vein was used. Recipient vein was anastomosed to the Internal Jugular Vein in an end-to-side manner. External Jugular Vein was the most commonly used vein followed by the Internal Jugular Vein. This is consistent with multiple studies.

The overall complication rate was as high as 17% and each complication could be attributed to one or more associated co-morbidity. The complication rate was higher in smokers, upto 60%, than non-smokers (7%). Flap congestion requiring re-exploration of the arterial and venous anastomosis was a common observation seen in 1 out of every 7 patients. This was clinically evident by the increased turgor, swelling and patchy discolouration of the flap and brisk capillary filling .It always leads to re-exploration because of the high stakes involved. Flap monitoring using clinical and spectro-photo-metric techniques, by a dedicated resident doctor or trained nurse is an essential requirement for the success of free flap surgery. In few cases, however, the intrinsic flap vasculature itself may be damaged due to tobacco use, vasculitis or systemic hypotension in multi-organ failure. In such patients, flap loss is inevitable.

Minor complications like wound dehiscence and wound infection can usually be managed early and successfully with least intervention. Donor site complications like delayed healing and wound dehiscence are similarly amenable to resolution by less invasive methods.

Functional recovery after reconstruction of head and neck using micro-vascularfree tissue transfer is usually satisfactory for the reconstructive surgeon but less than satisfactory for the patients. The patients report a return of swallowing, chewing and speech but not entirely satisfied with the cosmetic outcome ancd how it makes them feel.Most of the patients required adjunctive treatments like radiotherapy and chemotherapy and were referred for the same after 2-5 weeks of surgery, with a mean gap of 3 weeks between the Wide excision/reconstructive procedure and the start of adjunctive treatment.

CONCLUSION

Free tissue transfer in the head and neck region is a very reliable method for the reconstruction of complex three-dimensional defects created after onco-surgical resection.Though flap survival rates were high in our study, the complication rates were also high. This highlights the need for close monitoring of the flap, recipient and donor sites and prompt management of vascular complications. The return of function is satisfactory, even in defects where both internal and external linings are reconstructed, but cosmesis might be an issue. Referral for adjuvant treatments can also be done safely.

Funding

This research received no external funding.

Institutional Review Board Statement

The study was was approved by the Ethics committee of our institute

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest

The authors declare no conflict of interest.

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