Original Article

# Reconstruction in head-and-neck cancers – analysis of the learning curve


## ABSTRACT

**Background:** Oral cancers are some of the most common cancers in India. Most patients present with locally advanced disease requiring extensive resection resulting in large defects. Reconstruction of these defects plays a major role in restoring form and function to these patients, as well as enabling the delivery of adjuvant therapy on time.

**Aim of the Study:** The aim of this study was to analyze the learning curve involved in microvascular surgery.

**Materials and Methods:** A retrospective analysis of the case records of all patients of oral cancers, who underwent resection and reconstruction between January 2008 and December 2012 at our institute, was done. Demographic, clinical, and pathological data were collected and analyzed. Statistical analysis was done using the SPSS software.

**Results:** The operative time and the postoperative ventilation (7.8 h and 3.7 days, respectively) were significantly higher than those for pedicled flaps (3.6 h and 1.4 days, respectively). Both these variables reached statistical significance with $P < 0.05$ and $< 0.04$. The hospital stay was also statistically significantly longer for patients who underwent free-flap reconstruction (17.9 days vs. 7.9 days; $P < 0.05$). The number of reexplorations were higher in the free-flap group (31), when compared to the pedicled flap group (9). However, partial flap loss was higher in the pedicled flap subset when compared to the free-flap group. The complications significantly dropped after the performance of 30–40 free flaps.

**Conclusion:** There is a steep learning curve in microvascular surgery, but the cosmetic and functional outcomes outweigh the complications.


**Keywords:** Microvascular free flaps, oral cancers, pedicled flaps, reconstruction

## INTRODUCTION

The annual incidence of head-and-neck cancers worldwide is >550,000 cases with around 300,000 deaths occurring due to disease annually.[1] The sex ratio ranges from 2:1 to 4:1 (male:female). About 90% of all head-and-neck cancers are squamous cell carcinomas.[2] Oral cancers form the bulk of these tumors. In India, oral cancers consistently rank among the top two cancers in men with an incidence of 20/100,000.[3] This accounts for nearly 30% of the entire cancer burden of the country. Nearly 5 people in India die every hour, every day because of oral cancer.[3]

Surgery is the standard treatment to achieve cancer control, but due to socioeconomic and other factors, most patients present with a locally advanced tumor leading to extensive resection of mucosa, muscle, bone, and skin. Reconstruction of these defects is essential not only in ensuring function and cosmesis but also in enabling the start and completion of adjuvant therapy on time.[4]

We have analyzed a cohort of 326 patients of oral cancers, who underwent resection and reconstruction of their defects by various methods: from primary closure (used when the defect was 25%–30% of the volume) to split skin


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grafting and the usage of pedicled versus microvascular free flaps.

We placed special emphasis in our study, on the comparison between pedicled and microvascular flaps, to bring out the learning curve involved in the performance of free flaps as well as the morbidity which may accompany the performance of complex reconstructive procedures.

## MATERIALS AND METHODS

A retrospective review of the case records of all patients of oral cancers, who underwent surgery and some form of reconstruction at our institute was undertaken after obtaining due clearance from the Institute Ethical Committee. A total of 326 patients underwent surgery during the period of January 2008 to December 2012.

Demographic data, tumor factors, operative data such as the extent of resection, time taken for resection and reconstruction, blood loss, postoperative recovery, morbidity in terms of flap loss or reexploration to salvage a compromised flap, and the final pathological data were analyzed.

The operative team consisted of a qualified surgical oncologist trained in microvascular reconstruction (authors 1, 2 and 5), and plastic surgeons trained and experienced in microvascular reconstruction (authors 3 and 4). The same teams were involved in the patients undergoing pedicle flap reconstruction also.

### Outcome measures

The primary outcomes were major postoperative complications defined as any adverse event requiring intervention and/or prolonging the hospital stay. Surgical complications were defined as any adverse event at the local site, and medical complications were systemic events. The length of hospital stay was analyzed as a secondary outcome and was defined as the number of days in hospital from and including the day of surgery.

### Statistical analysis

Statistical analysis was performed using the SPSS version 10 software (IBM corporation, USA). The Chi-square test was used for categorical data and Fisher's exact test used where the frequency was small. Variables with $P = 0.05$ on univariate analysis were included in multivariate analysis.

## RESULTS

A cohort of 326 patients of oral cancers who underwent surgery and reconstruction at our institute were analyzed. Almost 67.4% of these patients were male, and 59.5% of these patients were younger than 50 years of age. The most common primary sites were the oral tongue (32.5%) and the buccal mucosa (in 30.1%) with or without involvement of the mandible and the floor of mouth complex. Most patients were chronic tobacco users, with a significant number reporting regular use of alcohol. About 78.5% of the patients presented with an ulcer or growth in the mouth as the primary symptom, whereas 39.2% presented due to bleeding from the tumor as the leading symptom [Table 1].

Most tumors were either T3 or T4, and pN2 disease was more common than pN1. Almost 68.7% of the tumors were well to moderately differentiated and 62.6% showed adverse histologic features such as lymphovascular invasion and perineural spread. About 27.3% had positive margins on final histopathology, mostly due to submucosal spread of the tumor [Table 2].

We used a variety of reconstructive modalities following resection of the tumor. Primary closure of the defect could be achieved in 13.1% of the patients and 5.5% of the patients received a split-thickness skin graft [Table 3].

Pedicled flaps (pectoralis major, latissimus dorsi, and deltopectoral) together constituted 179 (54.9%) of the reconstructive modalities used. As we had just started the microvascular program, there were only about 86 (26.3%) free flaps, of which the free fibula osteomyocutaneous flap was the most common, followed by the free radial artery forearm flap. The other free flap which we used was the free anterolateral thigh flap [Table 3].

We found that the mean operating time for a free-flap reconstruction (7.8 h) was nearly double that for other reconstruction modalities (3.6 h). The duration of postoperative ventilation was also significantly more (3.7 days versus 1.4 days) when compared to pedicled flaps. There was no significant difference in the mean blood loss or time to resumption of oral feeds between the two groups [Table 4].

The hospital stay in the free-flap group (17.9 days) was significantly longer than the other group (7.9 days), because of prolonged postoperative ventilation and also because of the increased incidence of flap reexploration and redo surgeries in the free-flap subset. Furthermore, it was our observation that the chances of excessive bleeding were higher in the free-flap group, probably due to the liberal use of anticoagulants [Table 4].

About 31 patients (36.04%) in the free-flap group needed reexploration for bleeding or for doubtful viability of the

flap. The most common causes which we encountered were thrombosis of the venous side of the anastomosis, kinking of the anastomosis, and arterial thrombosis; in that order. Complete flap loss in the free-flap group occurred in eight patients (three due to kinking, four due to venous thrombosis, and one due to arterial thrombosis). Partial flap loss was seen in 13 patients in the free-flap group and in 29 patients who had undergone pedicled flap reconstruction [Table 5].

The learning curve inherent in performing microvascular reconstruction is demonstrated in Figure 1, wherein it can be seen that most complications and reexplorations occurred in the first 25–30 patients of the free-flap group. As we gained experience, the next 50 patients had fewer redo surgeries and complications. Furthermore, we observed that this learning curve and morbidity were marked with respect to free fibula flaps and not so much in evidence when performing free radial artery forearm flaps.

The improvement in the results of the microvascular group was also due to the technical changes incorporated by us in the procedure such as:

a. Use of a higher-resolution microscope after the first few cases
b. Use of finer suture material (we started off with 7–0 prolene and changed to 9–0 prolene)
c. Compulsorily anastomosing two veins and using a vein graft if length was not sufficient
d. Possibly, due to the routine use of low-molecular weight dextran for 48 h postoperatively.

## DISCUSSION

Head-and-neck surgery was revolutionized by the application of pedicled and microvascular free flaps for reconstruction in the 1970s.[5] However, due to the perception of the unreliability of microvascular flaps, as well as the steep learning curve involved in performing them, free flaps in head-and-neck reconstruction did not come into common use for the next 10–15 years.[6]

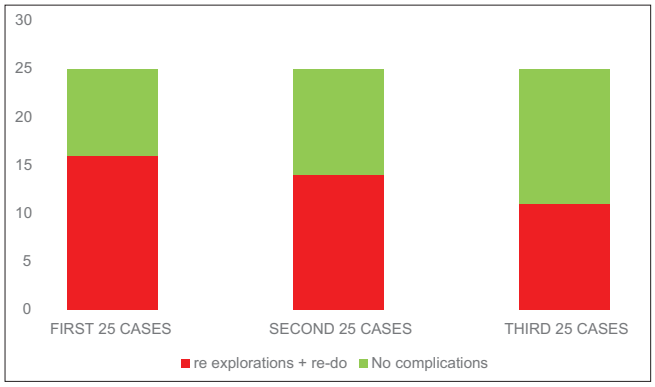


Figure 1: Learning curve in the free-flap group

**Table 1: Demographic features of the patient cohort (*n*=326)**

| Variable | Number of patients (%) |
|---|---|
| Gender | |
| Male | 220 (67.4) |
| Female | 106 (32.5) |
| Age (mean age 56.5±2) (years) | |
| <50 | 194 (59.5) |
| >50 | 132 (40.4) |
| Primary site | |
| Tongue | 106 (32.5) |
| Floor of mouth | 29 (8.8) |
| Buccal mucosa | 98 (30.1) |
| Alveolus | 56 (17.1) |
| Palate | 29 (8.8) |
| Lip | 8 (2.4) |
| Tobacco/alcohol usage | |
| Tobacco alone | 268 (82.2) |
| Tobacco + alcohol | 187 (57.3) |
| Symptomatology | |
| Ulcer | 256 (78.5) |
| Bleeding | 128 (39.2) |
| Pain | 83 (25.4) |
| Drooling of saliva | 75 (23.0) |
| Trismus | 68 (20.8) |

**Table 2: Pathological features of the tumors**

| Parameter | Number of patients (%) |
|---|---|
| Tumor stage | |
| T1 | 43 (13.1) |
| T2 | 62 (19.0) |
| T3 | 123 (37.7) |
| T4 | 98 (30.0) |
| Nodal status | |
| N1 | 146 (44.7) |
| N2 | 180 (55.2) |
| Grade of the tumor | |
| Well/moderately differentiated | 224 (68.7) |
| Poorly differentiated | 102 (31.2) |
| Adverse features | |
| LVI | 146 (44.7) |
| PNI | 91 (27.1) |
| Positive margins | 89 (27.3) |

LVI: Lymphovascular invasion, PNI: Perineural invasion

**Table 3: Reconstructive modalities used (*n*=326)**

| Type of reconstruction | Number of patients (%) |
|---|---|
| Primary closure | 43 (13.1) |
| Split-thickness skin graft | 18 (5.5) |
| Pedicled flaps | 179 (54.9) |
| Free fibula | 39 (11.9) |
| Radial forearm free flap | 28 (8.5) |
| Free anterolateral thigh flap | 19 (5.6) |

**Table 4: Comparison between free flaps and other reconstructive modalities**

| Parameter | Free flaps | Other reconstructive modalities | *P* |
|---|---|---|---|
| Operative time (h) | 7.8 (mean) | 3.6 (mean) | <0.05 |
| Blood loss (ml) | 850 (mean) | 680 (mean) | NS |
| Postoperative ventilation (days) | 3.6 | 1.4 | <0.04 |
| Tracheostomy duration (days) | 11.2 | 8.4 | NS |
| Nasogastric feeds (days) | 18.3 | 12.8 | NS |
| Hospital stay (days) | 17.9 | 7.9 | <0.05 |

NS: Not significant

**Table 5: Complications in the free-flap subset (*n*=86)**

| Complication | Number of patients (%) |
|---|---|
| Flap reexploration | 31 (36.04) |
| Partial flap loss | 13 (15.1) |
| Salivary fistula | 15 (17.4) |
| Complete loss requiring redo | 8 (9.3) |

As seen in our data also, most patients were reconstructed with a pedicled flap and the adoption of microvascular flaps as a routine form of reconstruction happened only in the second half of the study period.

The workhorse of the pedicled flap group was the pectoralis major myocutaneous flap, which was used in most patients. Even with our extensive experience in the usage of pedicled flaps, we had a 16.2% partial flap loss rate and a 9.2% salivary fistula rate in this group. This is supported by the data quoted by Leonard.[7]

In the microvascular flap group, the duration of surgery, postoperative ventilation, and hospital stay were significantly higher than the pedicled flap group. This is in concordance with the initial data reported by O'Brien *et al*.[8]

The partial flap loss rate and the salivary fistula rates were higher than those in the literature.[9,10] The most common flaps used for reconstruction of head and defects are the radial, free fibula, and the anterolateral thigh.[11] We observed that most of our complications occurred in the free fibula group and hardly any in the radial forearm group. The same finding by Jones *et al*. was explained as being due to a steeper learning curve in using a composite bone flap.[12] Singh *et al*. also reported an increased risk of flap failure in patients undergoing jaw (bone) reconstruction when compared to those undergoing only soft-tissue reconstruction.[13]

As seen in our data, and as mentioned in literature, the complication and flap loss rate are the highest in the first 25–50 cases of an microvascular program, and once, this learning curve is crossed, the flap loss rate is <5% in most series.[14,15]

Microvascular anastomoses have been shown to be less prone to thrombosis when their external diameter is more than 1 mm, and the vessel diameter is more than 2 mm.[16] Furthermore, the usage of free flaps with long vascular pedicles, which precludes the use of vein grafts was also found to prevent thrombosis.[17]

Patient comorbidities, age, and previous surgery or radiation are also factors which contribute to flap necrosis and failure.[18]

A survey of American academic institutions revealed the preferential use of pedicled flaps over microvascular reconstruction, due to (a) nonavailability of trained personnel and (b) perceptions about the unreliability of free flaps.[19] Hence, this reliance on pedicled flaps as the default reconstructive technique in head-and-neck cancers is not confined to the Indian subcontinent and the reconstructive philosophy of the head-and-neck surgeon needs to undergo a paradigm shift toward microvascular flaps.

## CONCLUSION

Although the complication rates in our study are higher than what is mentioned in the literature, this was our learning curve and after the first 40 cases, there was a significant reduction in flap reexplorations and flap loss. In spite of the steep learning curve, the free flap is an essential part of the head-and-neck surgeon's armamentarium and needs to be incorporated into training programs and clinical practice.

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### Conflicts of interest
There are no conflicts of interest.

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