



Original Article

Comparison of Free Flap versus Pedicled Flap Reconstruction in Oral Cavity Malignancies: A Retrospective–Prospective Cohort Study

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ABSTRACT

Background: Reconstruction following curative resection of oral cavity malignancies is essential for restoring form, function, and quality of life. Although microvascular free flaps are increasingly preferred for complex defects, pedicled flaps remain widely used, particularly in resource-limited settings.

Objective: To compare perioperative outcomes, postoperative complications, functional recovery, quality of life, delay in adjuvant therapy, recurrence, and mortality between free flap and pedicled flap reconstruction in patients with oral cavity malignancy.

Methods: This retrospective–prospective cohort study included 150 patients with histologically confirmed oral cavity malignancy who underwent curative-intent resection followed by immediate flap reconstruction. Patients were categorized into free flap and pedicled flap groups. Demographic, clinicopathological, operative, postoperative, functional, quality-of-life, adjuvant therapy, recurrence, and mortality data were analysed. Intergroup comparisons were performed using appropriate statistical tests, with $p < 0.05$ considered significant.

Results: Free flap reconstruction was associated with better postoperative functional outcomes, including speech, swallowing, mouth opening, and overall quality of life. Pedicled flap reconstruction showed a higher burden of postoperative complications and was more frequently associated with delay in initiation of adjuvant therapy. Recurrence and mortality were influenced by multiple oncological and patient-related factors rather than reconstructive method alone.

Conclusion: Free flap reconstruction provides superior functional rehabilitation and lower postoperative morbidity in suitable patients undergoing oral cavity cancer reconstruction. Pedicled flaps remain valuable alternatives in patients with significant comorbidity, financial constraints, high anaesthetic risk, or limited access to microsurgical facilities. Flap selection should be individualized according to defect characteristics, patient fitness, oncological requirements, and institutional resources.

Keywords: Oral cavity cancer; Free flap; Pedicled flap; Reconstruction; Functional outcome.

INTRODUCTION

Surgical resection is a key component of the curative treatment of resectable oral cavity malignancies and ablative surgery frequently leads to complex defects that affect speech, swallowing, mastication, oral competence, cosmesis and quality of life, especially in India where tobacco, areca nut use, alcohol consumption and late presentation play significant roles in the incidence and advanced stage presentation of oral cavity cancers. [1,2] Thus, adequate reconstruction is not only necessary for wound closure, but also for functional rehabilitation and timely delivery of adjuvant therapy.

Both pedicled regional flaps and microvascular free flaps are widely used for reconstruction of oral cavity defects. However, the pectoralis major myocutaneous flap is technically simple, has a good vascularity, a shorter operating time, and can be used in patients with significant comorbidity or limited access to microsurgical facilities.

The free flap versus pedicled flap reconstruction is still clinically relevant particularly in high-volume and resource-limited centres. The functional and quality-of-life results also have been shown to be superior with free flaps, and pedicled flaps remain important in select patients due to their lower cost, less complex surgery, and greater availability. Postoperative complications can also affect oncological outcomes by increasing the length of hospital stay and delaying the start of adjuvant radiotherapy, which is a known predictor of survival in head and neck cancers treated with surgery.

There is not much institution-specific evidence from Northeast India to compare these reconstructive approaches in oral cavity malignancy. Hence, the purpose of this study was to compare the perioperative, reconstructive, functional and short-term oncological outcomes of patients with oral cavity malignancies who underwent free flap and pedicled flap reconstruction at Assam Medical College and Hospital, Dibrugarh, Assam.

OBJECTIVES

1. Compare operative time, blood loss, ICU stay, hospital stay, oral intake day, and cost.
2. Compare flap loss, wound dehiscence, fistula, infection, donor-site morbidity, re-exploration, and overall complications.
3. Compare speech, swallowing, mouth opening, QoL, adjuvant delay, recurrence, and mortality.

METHODS

Study design and setting

This retrospective–prospective cohort study was conducted in the Department of Plastic Surgery, Assam Medical College and Hospital, Dibrugarh. Patients with oral cavity malignancy who underwent curative-intent surgical resection followed by immediate flap reconstruction were included. The study compared outcomes between patients reconstructed with microvascular free flaps and those reconstructed with pedicled flaps.

Study population

A total of 150 patients with histologically confirmed oral cavity malignancy were included. Patients were eligible if they underwent primary tumour resection with neck dissection, where indicated, followed by immediate reconstruction using either a free flap or a pedicled flap. Patients with incomplete records, recurrent malignancy at presentation, distant metastasis, palliative surgery, or inadequate follow-up were excluded.

Reconstructive procedures

Patients were divided into two groups according to the type of reconstruction performed. The free flap group included patients reconstructed with microvascular free tissue transfer, such as radial forearm free flap, anterolateral thigh flap, or other appropriate free flaps based on defect characteristics. The pedicled flap group included patients reconstructed with regional pedicled flaps, most commonly pectoralis major myocutaneous flap or other suitable pedicled options. Flap selection was based on tumour site, defect size and composition, patient fitness, vascular status, comorbidities, and availability of microsurgical resources.

Data collection

Demographic, clinicopathological, operative, and postoperative data were recorded. Baseline variables included age, sex, risk factors, comorbidities, tumour subsite, clinical stage, and histopathological diagnosis. Operative variables included type of resection, neck dissection, flap used, operative duration, blood loss, and hospital stay.

Outcome assessment

The primary outcomes were postoperative complications and functional recovery. Complications assessed included flap-related complications, wound infection, flap necrosis, orocutaneous fistula, donor-site morbidity, wound dehiscence, and need for re-exploration or secondary intervention. Functional outcomes included oral intake, speech, swallowing, and mouth opening. Quality of life was assessed during follow-up using the study's predefined assessment parameters.

Secondary outcomes included delay in initiation of adjuvant therapy, recurrence, and mortality. Delay in adjuvant therapy was defined as initiation of postoperative radiotherapy or chemoradiotherapy beyond six weeks after surgery.

Follow-up

Patients were followed postoperatively for wound healing, flap viability, complications, functional recovery, adjuvant treatment status, recurrence, and survival. Follow-up data were obtained from outpatient visits, hospital records, and treatment documentation.

Statistical analysis

Data were entered and analysed using appropriate statistical software. Continuous variables were expressed as mean with standard deviation or median with range, depending on distribution. Categorical variables were expressed as frequencies and percentages. Comparisons between the free flap and pedicled flap groups were performed using the Chi-square test or Fisher's exact test for categorical variables and the Student's *t* test or Mann-Whitney *U* test for continuous variables, as appropriate. A *p* value of <0.05 was considered statistically significant.

RESULTS

Study cohort and baseline characteristics.

A total of 150 patients with oral cavity malignancy who underwent flap reconstruction after curative-intent resection were included. The free flap group comprised 70 (46.7%) patients, while the pedicled flap group comprised 80 (53.3%) patients. The cohort had 113 (75.3%) males and 37 (24.7%) females, with a mean age of 53.6 ± 10.9 years. Patients in the pedicled flap group were older than those in the free flap group ($p < 0.001$), and serum albumin was modestly lower in the pedicled flap group ($p = 0.014$). ASA status also differed between groups ($p = 0.030$). Other major habits and comorbidities were broadly comparable between the two groups.

Table 1. Baseline demographic and clinical characteristics by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Age, years	49.5 \pm 10.6	57.1 \pm 10.0	t = -4.54	<0.001
Sex: Male	52 (74.3)	61 (76.2)	$\chi^2 = 0.01$	0.929
Female	18 (25.7)	19 (23.8)		
Residence: Rural	40 (57.1)	42 (52.5)	$\chi^2(2) = 1.52$	0.467
Semi-urban	11 (15.7)	19 (23.8)		
Urban	19 (27.1)	19 (23.8)		
BMI, kg/m ²	21.4 \pm 2.9	21.1 \pm 3.1	t = 0.59	0.555
Hemoglobin, g/dL	12.0 \pm 1.5	11.5 \pm 1.4	t = 1.92	0.057
Serum albumin, g/dL	3.7 \pm 0.4	3.6 \pm 0.4	t = 2.48	0.014
ASA status: I	14 (20.0)	5 (6.2)	$\chi^2(2) = 7.02$	0.030
II	41 (58.6)	50 (62.5)		
III	15 (21.4)	25 (31.2)		
Hypertension	14 (20.0)	24 (30.0)	$\chi^2 = 1.48$	0.224
Diabetes mellitus	12 (17.1)	22 (27.5)	$\chi^2 = 1.73$	0.188
Ischemic heart disease	2 (2.9)	11 (13.8)	$\chi^2 = 4.30$	0.038
Tobacco chewing	49 (70.0)	58 (72.5)	$\chi^2 = 0.02$	0.875
Smoking	24 (34.3)	33 (41.2)	$\chi^2 = 0.50$	0.479
Alcohol use	22 (31.4)	31 (38.8)	$\chi^2 = 0.58$	0.444
Betel nut use	43 (61.4)	52 (65.0)	$\chi^2 = 0.08$	0.777

Values are presented as mean \pm SD or n (%). χ^2 = chi-square test; Fisher exact test used where appropriate.

Tumour and pathological characteristics.

Buccal mucosa was the most common primary site, accounting for 66 (44.0%) cases. Advanced-stage disease was frequent, with stage III or IV disease present in 111 (74.0%) patients. Tumour site, clinical T stage, nodal stage, AJCC stage, tumour size, depth of invasion, bone involvement, margin status, pathological nodal positivity, extranodal extension, and planned adjuvant therapy were not significantly different between reconstruction groups.

Table 2. Tumour and pathological characteristics by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Primary site: Buccal mucosa	28 (40.0)	38 (47.5)	$\chi^2(5) = 7.38$	0.194
Oral tongue	15 (21.4)	14 (17.5)		
Lower alveolus/gingivobuccal sulcus	18 (25.7)	11 (13.8)		
Floor of mouth	6 (8.6)	10 (12.5)		
Retromolar trigone	2 (2.9)	7 (8.8)		
Lip	1 (1.4)	0 (0.0)		
Clinical T stage: T1	6 (8.6)	6 (7.5)	$\chi^2(3) = 1.03$	0.794
T2	21 (30.0)	30 (37.5)		
T3	18 (25.7)	17 (21.2)		
T4	25 (35.7)	27 (33.8)		
Clinical N stage: N0	39 (55.7)	36 (45.0)	$\chi^2(3) = 5.74$	0.125
N1	11 (15.7)	23 (28.7)		
N2	20 (28.6)	19 (23.8)		

N3	0 (0.0)	2 (2.5)		
AJCC stage: I	4 (5.7)	4 (5.0)	$\chi^2(3) = 0.09$	0.993
II	14 (20.0)	17 (21.2)		
III	29 (41.4)	32 (40.0)		
IV	23 (32.9)	27 (33.8)		
Tumor size, cm	4.7 ± 1.7	4.6 ± 1.7	t = 0.10	0.921
Depth of invasion, mm	11.8 ± 5.4	10.8 ± 4.7	t = 1.28	0.204
Bone involvement	15 (21.4)	23 (28.7)	$\chi^2 = 0.71$	0.401
Tumor grade: Well differentiated	11 (15.7)	17 (21.2)	$\chi^2(2) = 1.49$	0.475
Moderately differentiated	45 (64.3)	52 (65.0)		
Poorly differentiated	14 (20.0)	11 (13.8)		
Positive/close margin	4 (5.7)	9 (11.2)	$\chi^2 = 0.83$	0.362
Pathological node positivity	33 (47.1)	46 (57.5)	$\chi^2 = 1.22$	0.270
Extranodal extension	9 (12.9)	15 (18.8)	$\chi^2 = 0.58$	0.448
Adjuvant therapy planned	57 (81.4)	67 (83.8)	$\chi^2 = 0.03$	0.874

Values are presented as mean ± SD or n (%).

Operative and perioperative outcomes.

Radial forearm free flap was the most commonly used free flap (30 [42.9%]), followed by anterolateral thigh free flap (25 [35.7%]). In the pedicled flap group, pectoralis major myocutaneous flap was the predominant reconstruction (62 [77.5%]). Free flap reconstruction required significantly longer operative time and higher estimated direct cost. Pedicled flap reconstruction was associated with greater blood loss, longer hospital stay, and delayed initiation of oral intake, whereas ICU stay was longer in the free flap group. Transfusion requirement, tracheostomy use, and intraoperative complication frequency did not differ significantly between groups.

Table 3. Operative and perioperative outcomes by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Operative time, min	530.4 ± 77.4	386.1 ± 72.3	t = 11.75	<0.001
Estimated blood loss, mL	805.7 ± 230.4	919.5 ± 243.2	t = -2.94	0.004
Blood transfusion, units	0.8 ± 0.7	0.9 ± 0.8	t = -1.24	0.216
Tracheostomy performed	37 (52.9)	33 (41.2)	$\chi^2 = 1.58$	0.209
Intraoperative complication	2 (2.9)	3 (3.8)	Fisher exact; OR = 1.32	1.000
ICU stay, days	2.4 ± 0.7	1.6 ± 0.8	t = 6.15	<0.001
Hospital stay, days	14.3 ± 3.6	17.8 ± 3.9	t = -5.76	<0.001
Day of oral intake	8.4 ± 1.9	10.6 ± 2.4	t = -6.43	<0.001
Estimated direct cost, INR	163583 ± 29019	97208 ± 16774	t = 16.83	<0.001

Values are presented as mean ± SD or n (%). Estimated direct cost is reported in Indian rupees.

Postoperative complications

The overall postoperative complication rate was higher in the pedicled flap group than in the free flap group. Overall complications occurred in 22 (31.4%) patients in the free flap group and 47 (58.8%) patients in the pedicled flap group ($\chi^2 = 10.15$, p = 0.001). Donor-site morbidity was also higher in the pedicled flap group, affecting 16 (20.0%) patients compared with 4 (5.7%) patients in the free flap group (p = 0.020). Orocutaneous fistula occurred more frequently in the pedicled flap group, although this comparison did not reach conventional statistical significance.

Table 4. Postoperative complications and surgical morbidity by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Overall postoperative complication	22 (31.4)	47 (58.8)	$\chi^2 = 10.15$	0.001
Flap compromise	3 (4.3)	2 (2.5)	Fisher exact; OR = 0.57	0.665
Partial/total flap loss	1 (1.4)	5 (6.2)	Fisher exact; OR = 4.60	0.216
Re-exploration	3 (4.3)	2 (2.5)	Fisher exact; OR = 0.57	0.665
Wound dehiscence	9 (12.9)	10 (12.5)	$\chi^2 = 0.00$	1.000
Wound infection	7 (10.0)	15 (18.8)	$\chi^2 = 1.64$	0.201
Orocutaneous fistula	1 (1.4)	7 (8.8)	Fisher exact; OR = 6.62	0.068
Donor-site morbidity	4 (5.7)	16 (20.0)	$\chi^2 = 5.42$	0.020
Hematoma	0 (0.0)	3 (3.8)	Fisher exact	0.248
Chest complication	4 (5.7)	6 (7.5)	Fisher exact; OR = 1.34	0.751
Complication grade: None	48 (68.6)	33 (41.2)	$\chi^2(2) = 11.30$	0.004
Minor	18 (25.7)	37 (46.2)		
Major	4 (5.7)	10 (12.5)		

Values are presented as n (%). Fisher exact test was applied for sparse 2×2 comparisons.

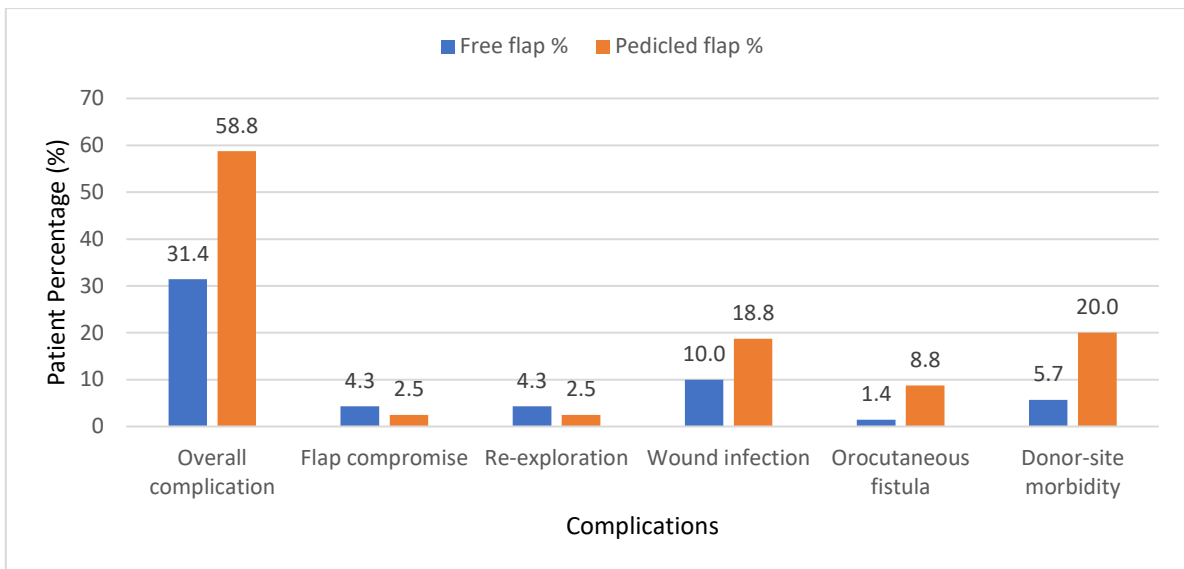


Figure 1. Postoperative complications profile by reconstruction group

Functional outcomes

Functional recovery favoured the free flap group. Good speech intelligibility was recorded in 46 (65.7%) patients after free flap reconstruction compared with 21 (26.2%) patients after pedicled flap reconstruction ($p < 0.001$). Normal or near-normal oral diet was achieved in 46 (65.7%) patients in the free flap group and 34 (42.5%) patients in the pedicled flap group ($p = 0.004$). Mouth opening and quality-of-life scores were also significantly higher in the free flap group.

Table 5. Functional outcomes at follow-up by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Speech intelligibility: Good	46 (65.7)	21 (26.2)	$\chi^2(2) = 26.09$	<0.001
Fair	24 (34.3)	52 (65.0)		
Poor	0 (0.0)	7 (8.8)		
Swallowing outcome: Normal/near normal oral diet	46 (65.7)	34 (42.5)	$\chi^2(2) = 11.18$	0.004
Soft/modified diet	24 (34.3)	40 (50.0)		
Feeding-tube dependent	0 (0.0)	6 (7.5)		
Feeding tube at 1 month	4 (5.7)	17 (21.2)	$\chi^2 = 6.25$	0.012
Feeding tube at 3 months	0 (0.0)	7 (8.8)	Fisher exact	0.015
Mouth opening, mm	29.5 \pm 5.8	25.4 \pm 5.5	t = 4.35	<0.001
QoL score (0–100)	68.0 \pm 11.0	59.9 \pm 12.7	t = 4.22	<0.001

Values are presented as mean \pm SD or n (%). QoL = quality of life.

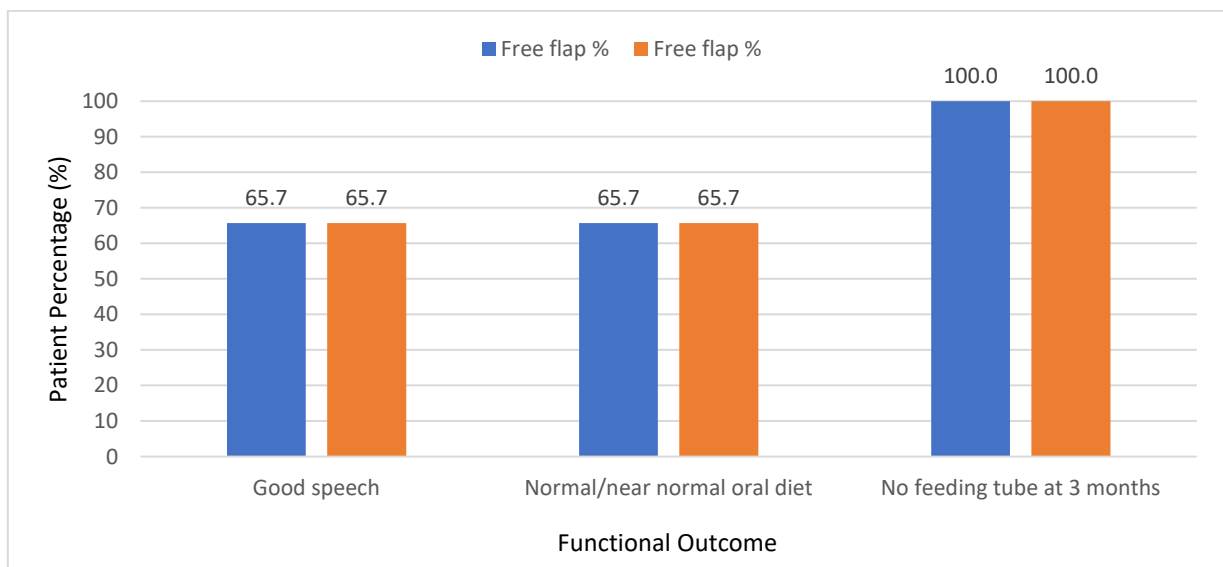


Figure2. Functional outcomes by reconstruction group

Adjuvant treatment and short-term oncological outcomes.

Adjuvant therapy was planned in a similar proportion of patients in both groups. Among patients for whom adjuvant therapy was planned, delay beyond 6 weeks was more frequent in the pedicled flap group. Adjuvant delay occurred in 29 (50.9%) planned cases in the free flap group and 55 (82.1%) planned cases in the pedicled flap group ($\chi^2 = 12.34$, $p < 0.001$). During follow-up, recurrence and mortality did not differ significantly between the reconstruction groups.

Table 6. Adjuvant treatment and short-term oncological outcomes by reconstruction group

Variable	Free flap	Pedicled flap	Test statistic	p value
Follow-up duration, months	14.1 ± 5.7	15.1 ± 5.6	t = -1.04	0.302
Adjuvant therapy planned	57 (81.4)	67 (83.8)	$\chi^2 = 0.03$	0.874
Adjuvant started among planned	56 (98.2)	64 (95.5)	Fisher exact; OR = 0.38	0.624
Adjuvant start day among treated	42.6 ± 9.9	51.3 ± 11.2	t = -4.55	<0.001
Adjuvant delay >6 weeks among planned	29 (50.9)	55 (82.1)	$\chi^2 = 12.34$	<0.001
Recurrence	8 (11.4)	14 (17.5)	$\chi^2 = 0.67$	0.414
Recurrence site: None	0 (0.0)	0 (0.0)	$\chi^2(3) = 8.36$	0.039
Local	6 (8.6)	2 (2.5)		
Regional	0 (0.0)	0 (0.0)		
Mortality	3 (4.3)	2 (2.5)	Fisher exact; OR = 0.57	0.665
Status at last follow-up: Alive disease-free	60 (85.7)	66 (82.5)	$\chi^2(2) = 1.14$	0.566
Alive with disease	7 (10.0)	12 (15.0)		
Dead	3 (4.3)	2 (2.5)		

Values are presented as mean ± SD or n (%). Percentages for adjuvant start and delay are calculated among patients with adjuvant therapy planned.

Adjusted analysis for overall postoperative complication.

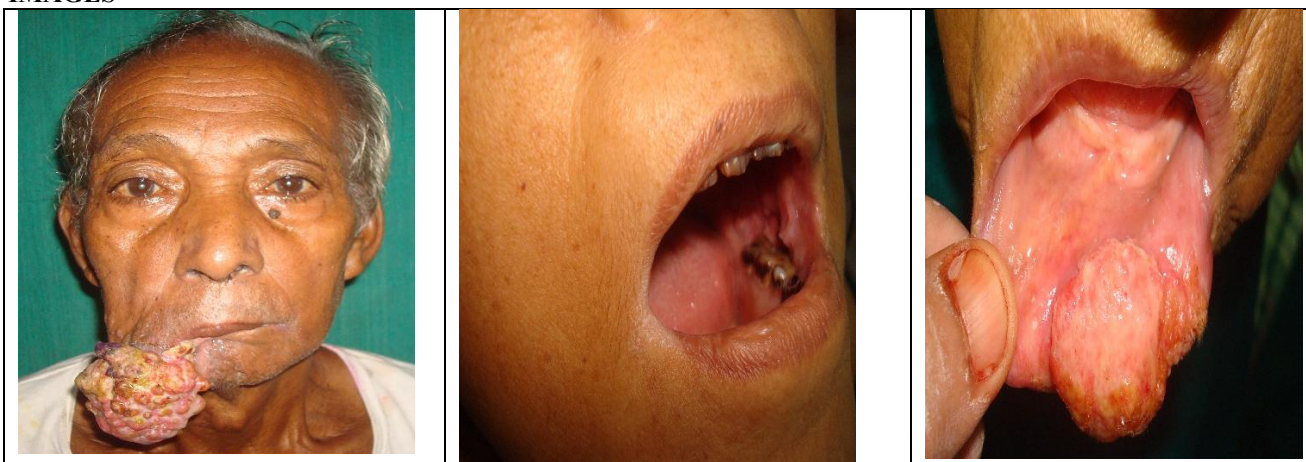
On multivariable logistic regression, pedicled flap reconstruction remained independently associated with higher odds of overall postoperative complication after adjustment for age, serum albumin, stage IV disease, and operative time. Longer operative time also showed a modest independent association with postoperative complications.

Table 7. Multivariable logistic regression for overall postoperative complication

Predictor	Adjusted OR (95% CI)	Wald z	p value
Pedicled flap reconstruction	7.17 (2.36-21.80)	3.47	<0.001
Age (per year)	0.99 (0.96-1.03)	-0.50	0.618
Serum albumin (per g/dL)	0.78 (0.34-1.76)	-0.61	0.545
Stage IV disease	1.14 (0.55-2.35)	0.35	0.726
Operative time (per 10 min)	1.05 (1.00-1.11)	2.14	0.032

Adjusted odds ratios are shown with 95% confidence intervals. The reference category for reconstruction type was free flap.

IMAGES

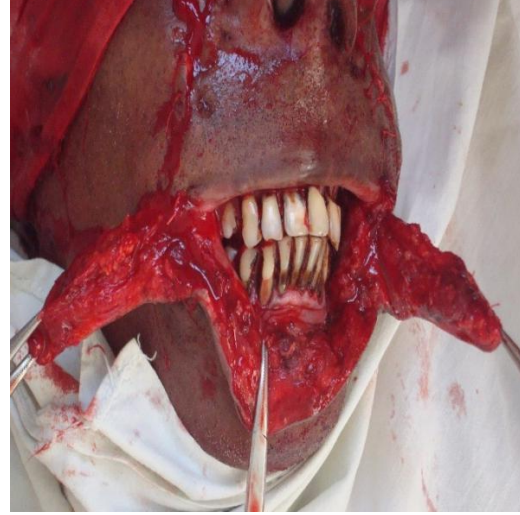




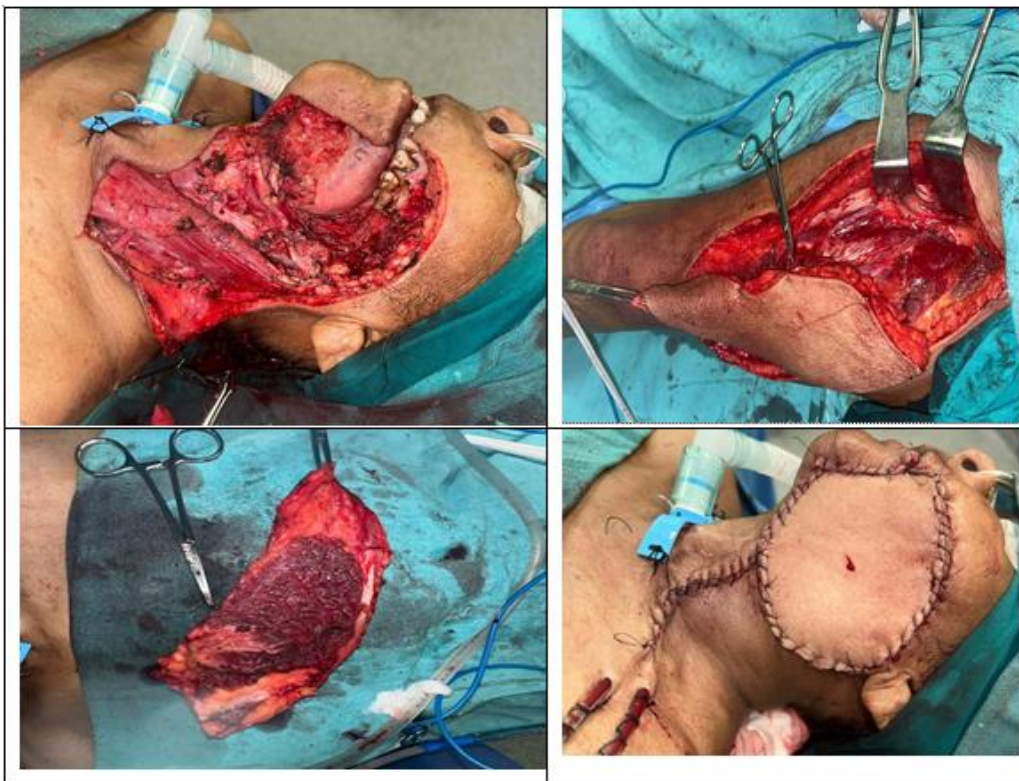
Oral cavity malignancies presenting in different sites of oral cavity



Karapandzic flap



Bilateral Nasolabial flap



Anterolateral Thigh(ALT) flap for reconstruction of oral cavity



Pectoralis Major Myocutaneous (PMMC) Flap

DISCUSSION

In this group, free flap reconstruction had fewer postoperative complications and better functional recovery than pedicled flap reconstruction. This is corroborated by Katsnelson et al., who reviewed 4,712 head and neck reconstruction cases from the ACS-NSQIP database and reported higher short-term postoperative morbidity with myocutaneous pedicled flaps, specifically infection, sepsis, and deep vein thrombosis, but no differences in readmission, reoperation, or length of stay. [9] Gabrysz-Forget et al., in a systematic review of 30 comparative studies, found that free flaps were associated with lower rates of infection and flap necrosis compared to pectoralis major myocutaneous flaps, but at the cost of longer operative time and higher cost. [10]

The improved speech, swallowing, mouth opening and quality of life in the free flap group is in line with previous functional studies. In a 13-year series of 114 patients reconstructed with either radial forearm free flap or pectoralis major myocutaneous flap, O'Neill et al. also reported significantly better speech performance with radial forearm free flap reconstruction. [12] Xiao et al. reported a 68.6% questionnaire response rate among 118 eligible patients and found better appearance, shoulder, and role-emotional domains after anterolateral thigh perforator free flap reconstruction compared with pectoralis major myocutaneous flap reconstruction. [13]

But free flaps aren't always the best option. Sittitrai et al. compared 171 oral cavity cancer patients (98 pedicled and 73 free flap reconstructions) and found no significant difference in the overall rate of complications at the recipient site, flap complications, speech, or swallowing. This is in keeping with the current interpretation that pedicled flaps are still suitable for selected patients, but free flaps are better for larger or more function demanding defects of the oral cavity. The use of resources is a key factor in high volume centres. In resource-limited settings, where theatre time, microsurgical skills, monitoring facilities and cost are factors that affect reconstructive decision making, the findings of McCrory and Magnuson, and Forner et al., are relevant.

The increased delay to adjuvant therapy noted in the current study following pedicled flap reconstruction is clinically relevant. Postoperative radiotherapy or chemoradiotherapy may be postponed due to wound complications, flap necrosis,

fistula, or dehiscence. Thus, the benefit of free flaps in the present study may be partly due to the decreased morbidity and earlier availability for adjuvant therapy.

Recurrence and mortality should be interpreted with caution as flap type alone is unlikely to affect tumour biology. Mahieu et al. evaluated 93 patients (64 pedicled and 29 free flap reconstructions), the majority of whom had oral cavity cancer. They did not find any significant differences in functional outcome, flap necrosis, complications, survival, recurrence or distant metastasis between the groups, and comorbidity was the most important factor affecting flap healing, not the type of flap used for reconstruction.

In conclusion, the current study confirms that free flap reconstruction is the method of choice in appropriate patients undergoing complex oral cavity reconstruction, especially when functional rehabilitation and timely adjuvant therapy are paramount. Pedicled flaps are still useful options in patients with extensive comorbidity, high anaesthetic risk, financial considerations, vessel depleted neck or limited microsurgical access. Flap selection should thus be tailored to the individual patient based on the nature of the defect, patient fitness, anticipated functional outcome, oncological treatment plan, and institutional resources.

CONCLUSION

Free flap reconstruction was correlated with better functional recovery, better quality of life, fewer postoperative complications and less delay in adjuvant therapy than pedicled flap reconstruction. These results suggest that microvascular free flaps are the best reconstructive choice for appropriate patients with complex oral cavity defects. However, pedicled flaps continue to have an important role in patients with significant comorbidity, high operative risk, financial limitations, or restricted access to microsurgical expertise. Hence, reconstruction should be tailored to the defect, patient, desired function and institutional resources.

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