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Soft-tissue reconstruction of the maxillofacial region with radial forearm free flap: A comprehensive study

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Abstract

Background: Reconstruction of maxillofacial soft-tissue abnormalities using a radial forearm free flap (RFFF) has become a recognized technique. In this study, the outcomes of RFFF reconstruction in relation to success rates, functional outcomes, and patient satisfaction are evaluated, and risk factors for complications are identified.

Methods: A retrospective cohort study was carried out on 40 patients who had RFFF reconstruction for maxillofacial defects. The inclusion criteria were age ≥18 years with soft-tissue defects that needed reconstruction. Data were collected on demographics, tumor details, surgical information, complications, and functional outcomes. Statistical analysis was done on the Statistical Package for the Social Sciences v26, and Chi-square tests and Cox proportional hazards regression were used to determine risk factors.

Results: A total of 40 patients were included in the study, comprising 23 males (57.5%) and 17 females (42.5%), with 45% being found to be aged between 30 and 50 years. Smoking history was noted in 55% of the patients. Intraoral defects accounted for 45% of the cases, and flap size (≤5 cm) was used in 100% of the reconstructions. Flap survival was achieved in 92.5% of cases, with good functional outcomes achieved in 65% for speech and 60% for swallowing. The patient satisfaction was satisfactory in 70% of the patients. In Cox regression analysis, smoking (hazard ratio [HR] 2.10, $P = 0.005$), large defect size (HR 2.50, $P = 0.002$), age >50 years (HR 1.75, $P = 0.018$), and tumor site (oral cavity) (HR 1.65, $P = 0.030$) were identified as significant risk factors for complications.

Conclusion: RFFF reconstruction has demonstrated high success rates and functional outcomes for maxillofacial defects. Cessation of smoking, careful patient selection, and consideration of defect size are essential for optimal outcomes. Low patient dissatisfaction supports RFFF as a reasonable reconstructive option.

Keywords: Maxillofacial, radial forearm free flap, reconstructive surgery

Introduction

Maxillofacial reconstruction is one of the most challenging types of reconstructive surgery, requiring exact restoration of both form and function in anatomically complex regions.[1] Microvascular free tissue transfer has revolutionized the management of extensive maxillofacial defects, with results that are much superior to those achieved with conventional methods of

reconstruction.[2] Among the many available free flaps to harvest, the radial forearm free flap (RFFF) has emerged as a consistent and reliable choice for head and neck soft-tissue reconstruction.[3] The RFFF, first described in 1981, has gained universal acceptance due to its optimum characteristics, such as thin, pliable tissue, reliable vascular anatomy, and relatively low donor site morbidity.[4] The flexibility of the flap is connected with the fact that it enables adequate soft-tissue coverage with the possibility of secondary procedures such as the insertion of osseointegrated implants.[5] Apart from this, the radial forearm flap can be harvested as a fasciocutaneous, osteocutaneous, or composite flap, depending on the type of reconstructive requirement.[6] Maxillofacial defects requiring reconstruction are frequently the consequence of oncological resections, trauma, congenital deformities, or infections.[7] The complexity of these defects often involves multiple anatomical structures, including the oral cavity, oropharynx, and adjacent soft tissues. Successful reconstruction not only involves correction of the structural defect but also restoration of vital functions such as speech, swallowing, and mastication.[8] The RFFF's thin, pliable nature particularly suits it for intraoral reconstruction, where bulk can significantly affect functional outcomes.[9] Further refinements in microsurgical technique have improved free tissue transfer outcome rates, with recent series reporting over 95% flap survival rates.[10] However, a variety of factors continue to influence outcomes, including patient age, comorbidities, defect size and site, and surgical technique.[11] Smoking has been consistently demonstrated to be a risk factor for flap complications, affecting both microvascular patency and wound healing.[12] Functional assessment following maxillofacial reconstruction has increased in importance, with an emphasis on objective quantification of speech intelligibility and swallowing function.[13] Patient-reported outcome measures have also assumed a larger role, providing valuable data about quality of life and satisfaction following reconstruction.[14] The use of multidisciplinary care, including speech therapy and nutrition support, has been shown to optimize functional outcomes.[15] Despite the established role of RFFF in maxillofacial reconstruction, there is continued research to better define patient selection criteria and refine surgical technique. Current research is aimed at minimizing donor site morbidity, optimizing flap design, and improving functional outcomes with new surgical techniques.[16] The development of perforator-based flaps and the use of supermicrosurgery techniques are areas of increasing interest.[17] This study aims to evaluate the outcomes of RFFF maxillofacial reconstruction with a particular emphasis on soft-tissue reconstruction, functional outcomes, and patient satisfaction. By analyzing a contemporary patient population, we aimed to identify variables associated with successful outcomes and provide evidence-based recommendations for clinical practice.

Methods

This retrospective cohort study was conducted at Ahsania Mission Cancer and General Hospital, Dhaka Specialized Hospital, and Uttara Adhunik Medical College and Hospital, Dhaka, Bangladesh, from April 2020 to March 2025. A total of 40 patients who underwent RFFF reconstruction for maxillofacial defects were included in this study. Inclusion criteria were patients aged 18 years or older with soft-tissue defects in the oral cavity, oropharynx, or adjacent structures requiring reconstruction with RFFF. Exclusion criteria included incomplete medical records or follow-up shorter than 6 months. Data were collected from patient records, including demographic variables (age, gender, and smoking status), tumor characteristics (location and size), surgical details (flap size and donor site morbidity), post-operative complications, and functional outcomes (speech and swallowing). Functional outcomes were assessed by clinical examination and patient-reported questionnaires. Flap success was defined as complete survival of the flap with no necrosis, while complications included infection, hematoma, or partial/total flap loss. Statistical analysis was performed using Statistical Package for the Social Sciences version 26.0. Categorical variables were expressed as frequencies and percentages,

and continuous variables were summarized as means and standard deviations. Associations between categorical variables were analyzed using the Chi-square test or Fisher's exact test as appropriate, whereas $P < 0.05$ was considered statistically significant. Cox proportional hazards regression was conducted to identify factors associated with flap failure or complications, and results were reported as hazard ratios (HRs) with 95% confidence intervals (CIs). This study was approved by the Institutional Review Board of Ahsania Mission Cancer and General Hospital, and informed consent was waived due to its retrospective nature.

Results

Table 1 presents the demographic characteristics of the 40 patients who underwent RFFF reconstruction. The study population was predominantly male versus female (57.5% vs. 42.5%), both statistically significant (P = 0.001). The distribution of age showed 45% of patients were in the 30–50 years age group, followed by 35% in more than 50 years, and 20% in <30 years (P = 0.045). A history of smoking was present in 55% of patients, a significant risk factor (P = 0.032). The tumor sites showed involvement of the oral cavity in 50% of the cases, the oropharynx in 30%, and other sites in 20% (P = 0.010), which are the typical sites that require reconstruction.

Table 2 presents the nature of defects requiring reconstruction, categorizing the types of defects that necessitated RFFF reconstruction. Intraoral defects (floor of mouth and tongue) were the most common indication and accounted for 45% of cases (P = 0.015). Extraoral defects of the skin and cheek accounted for 30% of cases, while combined intraoral and extraoral defects accounted for 25% of the cohort. The frequency of intraoral defects highlights the usefulness of RFFF for the supply of thin, pliable coverage tissue in difficult oral cavity reconstruction.

Table 3 demonstrates the flap sizes and associated donor site morbidity, including the size of the flaps employed and any complications observed at the donor sites. Flap sizes chosen are all ≤5 cm, with a P = 0.08. Donor site difficulties occurred in 20% of the cases, whereas the remaining 80% had no complications (P = 0.037). The donor site morbidity rate is low, demonstrating the safety profile of RFFF collection.

Table 1: Basic characteristics of the study population (n=40)

Characteristic	Frequency (n)	Percentage	P-value
Gender			
Male	23	57.5	0.001
Female	17	42.5	
Age group			
<30 years	8	20	0.045
30–50 years	18	45	
>50 years	14	35	
Smoking history			
Smoker	22	55	0.032
Non-smoker	18	45	
Tumor site			
Oral cavity	20	50	0.010
Oropharynx	12	30	
Other	8	20	

Table 2: Type of defect requiring reconstruction (n=40)

Type of defect	Frequency (n)	Percentage	P-value
Intraoral (e.g., tongue, FOM)	18	45	0.015
Extraoral (e.g., skin, cheek)	12	30	
Combined	10	25	

FOM: Floor of mouth

Table 3: Flap characteristics and donor site morbidity (n=40)

Flap characteristics	Frequency (n)	Percentage	P-value
Flap size (≤5 cm)	40	100	0.08
Donor site complications			
Yes	8	20	0.037
No	32	80	

Table 4 evaluates the functional outcomes following RFFF reconstruction, specifically focusing on speech and swallowing functions. Speech outcome was good in 65% of patients, moderate in 25%, and poor in only 10% (P = 0.021). Similarly, swallowing function was good in 60% of patients, moderate in 30%, and poor in 10% (P = 0.015). These results show that RFFF reconstruction yields satisfactory functional outcomes in the majority of patients.

Table 5 represents the primary outcome measures, highlighting flap survival rates and post-operative complications. Flap survival was seen in 92.5% of the patients, partial necrosis in 5%, and total flap loss in only 2.5% (P = 0.003). Post-operative complications included infection in 15% and hematoma in 10% of the patients, whereas 75% of the patients had no complications (P = 0.040). The success rate of 92.5% is consistent with contemporary microsurgical standards and is a testament to the reliability of RFFF for maxillofacial reconstruction.

Table 4: Functional outcomes (speech and swallowing) (n=40)

Functional outcome	Frequency (n)	Percentage	P-value
Speech			
Good	26	65	0.021
Moderate	10	25	
Poor	4	10	
Swallowing			
Good	24	60	0.015
Moderate	12	30	
Poor	4	10	

Table 5: Flap survival and complications (n=40)

Complication/ survival	Frequency (n)	Percentage	P-value
Flap survival			
Successful	37	92.5	0.003
Partial necrosis	2	5	
Total flap loss	1	2.5	
Post-operative complications			
Infection	6	15	0.040
Hematoma	4	10	
None	30	75	

Table 6 displays the results of the Cox proportional hazards regression analysis, identifying statistically significant risk factors for flap failure through multivariate analysis. Age >50 years had an HR of 1.75 (95% CI: 1.10–2.78, P = 0.018), indicating 75% more risk of complications. History of smoking indicated the most risk with HR 2.10 (95% CI: 1.25–3.52, P = 0.005). Defect size large (>50 cm^2) had HR 2.50 (95% CI: 1.40–4.48, P = 0.002), and oral cavity location had HR 1.65 (95% CI: 1.05–2.60, P = 0.030). Male gender was not significant (HR 1.20, P = 0.420). These findings provide evidence-based risk stratification for patient counseling and surgical planning.

Table 7 presents overall patient satisfaction, based on patient-reported outcomes following RFFF reconstruction. The majority of patients (70%) were very satisfied, 20% moderately satisfied, and only 10% dissatisfied (P = 0.012). This high satisfaction rate reflects the successful restoration of function and form, verifying the effectiveness of

Table 6: Cox proportional hazards regression analysis of factors associated with flap failure

Variable	Hazard ratio	95% confidence interval	P-value
Age (>50 years)	1.75	1.10–2.78	0.018
Male gender	1.20	0.75–1.95	0.420
Smoking history	2.10	1.25–3.52	0.005
Defect size (>50 cm^2)	2.50	1.40–4.48	0.002
Tumor site (oral cavity)	1.65	1.05–2.60	0.030

Table 7: Overall patient satisfaction

Satisfaction level	Frequency (n)	Percentage	P-value
Highly satisfied	28	70	0.012
Moderately satisfied	8	20	
Dissatisfied	4	10	

RFFF reconstruction from the patient's perspective. The finding of statistical significance indicates that patient satisfaction was not neutral but significantly positive. Good functional outcomes and esthetic outcomes are expressions of high patient satisfaction. The low dissatisfaction rate (10%) compares with other reconstructive techniques, vindicating the continued use of RFFF for maxillofacial reconstruction.

Discussion

This series demonstrates the effectiveness of RFFF reconstruction for maxillofacial soft-tissue defects, with excellent success and functional outcomes. Our 92.5% flap survival rate conforms to current microsurgical standards and supports the reproducibility of RFFF for complex head and neck reconstruction.[18] These results are in agreement with recent meta-analyses by Hartl *et al*. of head and neck free flaps yielding success rates over 95%.[19] The demographic profile of our study population, with male predominance (57.5%) and prevalence of high smoking (55%), reflecting the prevalence profile of patients requiring maxillofacial reconstruction, is appropriately captured. The significant correlation of smoking with flap complications (HR 2.10, $P = 0.005$), with it being consistent with evidence from Crippen *et al*., pointing toward the negative effect of tobacco on microvascular results,[12] underscores the crucial role of pre-operative cessation counseling and its support toward aggressive perioperative optimization protocols. Our functional outcome assessment revealed adequate speech and swallowing function in 65% and 60% of patients, respectively. This result compares favorably with Eskander *et al*. employing RFFF for oral cavity reconstruction, where functional results are subject to the site and extent of the defect.[8] The pliable consistency and thinness of radial forearm tissue contribute to improved functional results over more voluminous flap options, particularly in intraoral reconstruction.[20] The predominance of intraoral defects (45%) in our series suggests optimal matching of flap nature to reconstructive demand. The description of defect size as a principal risk factor (HR 2.50 for defects >50 cm^2) is of clinical significance. Large defects require not only huge coverage but also technical issues in terms of flap inset and vascular anastomosis.[3] These findings support careful pre-operative planning and consideration of other reconstructive options for extensive defects. The oral cavity location of the tumor site, concerning increased risk of higher complications (HR 1.65), may be related to the technical challenge of intraoral reconstruction as well as the restriction of post-operative care within the contaminated oral environment.[21] 70% high satisfaction and 20% moderately satisfied patient rates indicate the positive impact of RFFF reconstruction on quality of life. These findings, as reported by patients, are critical in evaluating success beyond objective clinical measures.[22] The satisfactory aesthetic and restoration of function likely underlie the high satisfaction rates. Low donor site morbidity (20%) reported in this study supports the safety profile of RFFF harvest. Current techniques of donor site management, including primary closure and skin grafting methods, have minimized complications successfully compared to historical series.[23] Donor site assessment over time, however, remains useful for a complete evaluation of outcomes. Our regression modeling provides useful risk stratification data to guide clinical decision-making. The increased risk with advanced age (HR 1.75 for >50 years) reflects the impact of comorbidity and reduced physiological reserve on microsurgical outcomes.[24] These findings validate individualized patient assessment and perioperative optimization strategies. Retrospective study design and single-institutional experience are study limitations inherent in the study. However, the concurrence of our findings with contemporary literature supports the external validity of our observations.

Limitations of the study

The study has several limitations, including being retrospective in nature and hence subject to selection bias and constraining the quality of data collection. The lower sample size ($n = 40$) versus the population of concern may constrain

the statistical power as well as the generalizability of the findings to larger populations. Further, the follow-up duration was 6 months, which may not be able to detect long-term complications or functional outcomes.

Conclusion

This study confirms that RFFF reconstruction is an effective and safe approach to maxillofacial soft-tissue defects with high rates of success (92.5%) and tolerable functional outcomes. Smoking history, advanced age, size of the defect, and location in the oral cavity were major risk factors for complications. Most patients experienced satisfactory functional outcomes and a high level of satisfaction, which validates the ongoing use of RFFF as a valuable reconstructive option. Perioperative optimization and judicious patient selection are essential to achieve optimal outcomes.

Recommendations

Future studies should investigate long-term functional results and quality of life assessment with extended follow-up periods. Comparative effectiveness research between RFFF and alternative reconstructive strategies would provide clinically relevant information for decision-making. The establishment of predictive models utilizing discovered risk factors could also refine patient counseling and surgical planning.

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Conflicts of interest

None declared.

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