

**Original Article**

# COMPARISON OF COMPLICATIONS AND FUNCTIONAL OUTCOMES OF SUBMENTAL ISLAND FLAP VS RADIAL FOREARM FLAP FOR RECONSTRUCTION OF TONGUE DEFECTS IN SQUAMOUS CELL CARCINOMA

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**ABSTRACT**

**Objectives:** To compare postoperative complications and functional outcomes of submental island flap versus radial forearm used in reconstruction of tongue defects in squamous cell carcinoma patients.

**Materials and Methods:** After receiving approval from the Ethical Review Committee, this study was carried out in a tertiary care center's Department of Oral and Maxillofacial Surgery (Ref. No: 10130425MAOM). It comprised 60 patients in a non-randomized control trial, 30 in each group, between the ages of 18 and 70, who were undergoing surgical reconstruction and resection for squamous cell carcinoma of the tongue. Depending on the size of the defect, patients were randomized to either the radial forearm free flap group or the submental island flap group. Poor nutrition (BMI <18.5 or >35), substance abuse, active oral infections, severe comorbidities, previous head and neck radiation, recurrent disease, and prior reconstruction were all excluded. Adults aged 18–70 years undergoing tongue reconstruction were included. Functional outcomes (speech, swallowing, mobility) and complications (infection, wound dehiscence, necrosis, donor-site morbidity) were assessed at 1-week and 15-day follow-up. Data were analyzed with SPSS 22 using chi-square/Fisher's exact tests, with effect sizes and 95% confidence intervals reported. Qualitative variables were presented as percentages and frequencies, while quantitative variables were summarized as mean ± SD or IQR. A p-value of less than 0.05 was deemed statistically significant.

**Results:** Among the 159 participants, the mean age was 33.08 ± 8.83 years, with a higher proportion of males (n=95, 59.7%). While most respondents recognized the benefits of laser technology in endodontics, practical application was limited, with only 4.4% reporting its use. Significant differences were observed between respondents with 1-4 years and 5-8 years of experience in their familiarity with laser technology and beliefs about its application and outcomes. Barriers to adoption included cost concerns and perceived training accessibility.

**Conclusion:** For tongue reconstruction, RFFF and SMIF both demonstrated comparable healing and functional results, demonstrating their efficacy and dependability. However, SMIF provides a less invasive alternative that is perfect for moderate defects because it requires less time during surgery and has less donor-site morbidity.

**Key words:** Radial forearm free flap, reconstruction, submental island flap, squamous cell carcinoma, tongue cancer

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**INTRODUCTION**

The most common malignant tumor in the oral cavity is tongue cancer, which primarily affects the anterior tongue. Its incidence has significantly increased over the last few decades, partly due to rising rates among women and younger adults, and it

now accounts for a sizable portion of head and neck cancers. According to estimates, tongue cancers, and more generally, tumors of the oral cavity, account for between 25% and 33% of all head and neck cancers<sup>1</sup>. Since surgical resection offers the best chance of achieving local disease control, it continues to be the mainstay of treatment for tongue cancer. With reported 5-year survival rates considerably higher than nonsurgical modalities, patients can achieve favorable long-term outcomes when performed with adequate oncologic margins through radical or wide excision<sup>2</sup>. Nonetheless, the tongue plays a vital role in speaking, swallowing, and supporting the mouth cavity's masticatory processes. When tongue cancer is removed completely, corresponding defects are frequently left behind. These defects have a detrimental effect on the function and appearance of the tongue as well as the patients' quality of life after surgery. When a tongue defect reaches a certain point, tongue reconstruction is therefore necessary to maximize the recovery of tongue function and enhance the patient's quality of life<sup>3</sup>.

When it comes to rebuilding the tongue after surgery, the radial forearm free flap has long been the go-to choice because of its thin, flexible tissue that helps patients regain speech and movement. However, the submental island flap has become a promising alternative to radial forearm flap these days. It is easier to harvest, leaves fewer problems at the donor site, and allows for a quicker recovery, making it a practical option for many patients. These qualities make it an appealing choice, particularly in patients where microsurgical reconstruction may not be feasible or desirable<sup>4</sup>. The mobility and volume of the reconstructed tongue dictate the functional results of oral tongue reconstruction. Radial Forearm free flaps are flexible and thin, whereas submental island flaps offer sufficient thickness<sup>5</sup>. The submental island flap has been recognised as being a useful local flap for oral cavity reconstruction given its reliability, the low donor site morbidity and the short operative time<sup>6</sup>. Submental Island flap reconstruction of hemitongue defects following cancer ablation had a 96.7% success rate<sup>7</sup> Wound dehiscence at the Submental island flap donor site has been reported infrequently (0-7.4%) in the literature. On the other hand, a sizable portion of patients who had Radial forearm flap reconstruction have been found to have limited arm function and partial skin loss<sup>5</sup>.

One of the most commonly used techniques for reconstructing head and neck defects is microvascular free tissue transfer, especially the radial forearm flap. It provides dependable functional and aesthetic results, restoring both form and oral competence, with success rates reported to be between 94% and 96%. Reconstructive surgeons around the world favor it because of its adaptability, predictable vascular anatomy, and advantageous donor-site features<sup>8</sup>. Since they restore both form and mobility, microvascular free flaps are generally considered the gold standard for tongue reconstruction because they produce excellent functional and aesthetic results. Pedicled flaps are still useful, though, especially for older patients, those with poor diets, or those with serious comorbidities who might not be able to handle lengthy surgical procedures. Pedicled flaps provide a dependable and safe substitute in these situations, striking a balance between patient-centered care and surgical viability<sup>9</sup>. Given that the survival rate of free flaps has increased to over 90% at the majority of centers, surgeons' main concerns at the moment are the function and appearance of the donor and recipient sites<sup>10</sup>.

The purpose of this research is to assess and contrast the functional results and postoperative complications after surgically excising oral tongue cancer that has been rebuilt using a submental island flap or a radial forearm free flap. The study compares the two methods in order to ascertain which strikes the best balance between long-term functionality and surgical risks. Despite being known as a dependable workhorse flap, the radial forearm free flap has a number of donor site complications of its own. However, the submental island flap provides a less invasive option that is especially appropriate for certain patient populations. The ultimate goal of this comparison is to help surgeons select the most efficient and patient-focused reconstructive procedure.

## **MATERIALS AND METHODS**

The study was conducted at the Oral and Maxillofacial Surgery Department providing a tertiary care setting for tongue cancer reconstruction. The study was approved by the Ethical Review Committee, Reference No: 10130425MAOM. The target population included subject's aged 18 to 70 years undergoing tongue cancer reconstruction. Inclusion criteria was Patients aged 18-70 years, either gender,

patients diagnosed with squamous cell carcinoma of tongue and patients undergoing surgical resection and reconstruction of tongue defects. Exclusion criteria was Patients with recurrent tongue cancer, Patient with previous reconstructive surgery of tongue, patients with severe comorbid conditions contradicting surgery, patient with history of substance abuse that could interfere with post-operative care and recovery, Patients who have received prior radiation to the head and neck region, Patient with poor nutritional status that may affect wound healing and recovery indicated by Body Mass Index (BMI) less than 18.5 or greater than 35 and lastly, patient with active oral infections that could complicate surgical site or reconstruction process. A sample size of 30 patients in each group was determined using OpenEpi sample size calculator taking 30 % of infection for submental Island flap and 3.5% [5] for radial forearm free flap at 95% C.I and power 80 %. The participants were selected through a Non probability consecutive sampling method. Patients were allocated to the SMIF or RFFF group based on defect size (size 2-4mm will undergo submental island flap and size >4mm will undergo radial forearm) and reconstructive requirements, rather than by randomization. Therefore, this study represents a prospective, non-randomized comparative clinical study. The study duration was 6 months after synopsis approval. Patients were scheduled for regular follow-up visits at 1 week and 15 days post-surgery. These visits involved the collection of the information regarding complications (wound dehiscence, flap necrosis, infection, and donor site morbidity) and functional outcome (mobility, speech quality and swallowing). No missing outcome data occurred because all enrolled patients completed both follow-up visits. Written informed consent was obtained from eligible participants after explaining the study's objectives, risks, and benefits. Baseline information, including age, gender, weight, height, BMI, diabetic and hypertensive status was collected through a predesigned questionnaire. After reconstruction with Submental island flap or radial forearm flap patients were evaluated for wound dehiscence, difficulty swallowing liquids, difficulty swallowing solids, sensory loss at donor site, ability to hold objects, infection and necrosis. All collected data was entered on Excel. After collection of the data the data analysis was performed using the software Statistical Package for Social Science (SPSS), Version 22. Normality of the data was measured using Shapiro

Wilk. Quantitative variable age, BMI, size, height, weight were regarded as mean and standard deviation / IQR. Qualitative variable such as gender, flap type, flap necrosis, wound dehiscence, swallowing, Ability to hold objects were presented as frequency and percentage. Complication rates and functional outcomes between the two groups was compared using Fischer Exact test/Chi Square test for categorical variables (flap type, flap necrosis, wound dehiscence, swallowing, ability to hold objects). A p-value of <0.05 was considered statistically significant.

## RESULT

In this study, 60 patients undergoing tongue reconstruction were evaluated, 30 were treated with radial forearm free flap (RFFF) and 30 patients with Submental Island Flap (SMIF). The mean age was 55.45 and comprised 37 (61.7%) males and 23 (38.3%) females.

Overall flap necrosis was observed in 3 (5%) (TABLE 1) patients all of which were from Radial forearm free flap reconstruction whereas there was no flap necrosis with SMIF. Wound dehiscence was observed in 5 (16.7%) RFFF and none in SMIF ( $p = 0.706$ ). Infection developed in 3 (10%) RFFF and 5 (16.7%) SMIF patients ( $p = 0.706$ ). (TABLE 2) Regarding functional outcomes, 5 (16.7%) RFFF and 4 (13.3%) SMIF patients reported difficulty swallowing liquids ( $p = 0.237$ ), while 26 (86.7%) RFFF and 28 (93.3%) SMIF patients reported difficulty swallowing solids ( $p = 0.6707$ ) (TABLE 3). The ability to hold objects was retained in 26 (86.7%) RFFF and all 30 (100%) SMIF patients ( $p = 0.1124$ ). No sensory loss at the donor site was reported in either group.

Effect sizes with 95% CIs showed no statistically significant differences for most outcomes. The risk difference for flap necrosis was 10% (95% CI: -2.1% to 22.1%). Wound dehiscence showed a clinically meaningful difference of 16.7% (95% CI: 3.5% to 29.9%) favoring SMIF. Infection rates (RD = -6.7%; 95% CI: -20.4% to 7.1%), difficulty swallowing liquids (RD = 3.4%; 95% CI: -12.4% to 19.3%), difficulty swallowing solids (RD = -6.6%; 95% CI: -21.2% to 8.1%), and donor-site function (RD = -13.3%; 95% CI: -27.9% to 1.3%) all demonstrated overlapping confidence intervals, indicating no significant differences between flaps

There were no statistically significant differences

between the two flap techniques, suggesting that both SMIF and RFFF produced results that were similar in terms of functional recovery and postoperative complications.

**DISCUSSION**

In this prospective comparative study of 60 patients undergoing tongue reconstruction following squamous cell carcinoma resection, we discovered no statistically significant differences between radial forearm free flap (RFFF) and submental island flap (SMIF) in postoperative complications or early functional outcomes. Wound dehiscence was observed in 5 RFFF patients and none in SMIF ( $p = 0.706$ ), infection rates were comparable (RFFF 3 vs. SMIF 5;  $p = 0.706$ ), and flap necrosis was observed in 3 RFFF patients and none in the SMIF group ( $p = 0.237$ ). Functional outcomes, such as the inability to hold objects and swallow liquids or solids, were essentially similar between groups, and neither flap was associated with any sensory loss at the donor

site. Overall, these findings show that the pedicled SMIF avoids the need for microvascular anastomosis while producing results comparable to the RFFF for properly chosen medium-sized tongue defects.

Our results are consistent with a number of systematic reviews and comparative clinical series. In

**Table 1: Descriptive statistics for distribution of qualitative variable**

Gender	Frequency	Percentage
Male	37	61.7%
Female	23	38.3%
<b>Flap type</b>		
RFFF	30	50%
SMIF	30	50%
<b>Flap Necrosis</b>		
No	57	95%
Yes	3	5%
<b>Wound Dehiscence</b>		
No	52	86.7%
Yes	8	13.3%

**Table 2: Comparison of complication in RFFF versus SMIF**

Necrosis	RFFF		SMIF		P-value
	Frequency	%	Frequency	%	
Yes	03	90	0	0	0.237
No	27	10	30	100	
<b>Wound Dehiscence</b>					
Yes	05	16.7	0	0	0.706
No	25	83.3	30	100	
<b>Infection</b>					
Yes	03	10	05	16.6	0.706
No	27	90	25	83.3	

**Table 3: Comparison of functional outcome in RFFF versus SMIF**

Difficulty Swallowing Liquids	RFFF		SMIF		P-value
	Frequency	%	Frequency	%	
Yes	05	16.7	04	0	0.237
No	25	83.3	26	100	
<b>Difficulty Swallowing Solids</b>					
Yes	26	86.7	28	93.3	0.6707
No	04	13.3	02	6.6	
<b>Able to hold objects</b>					
Yes	26	86.7	30	100	0.1124
No	04	13.3	0	0	
<b>Sensory loss at donor site</b>					
Yes	0	0	0	0	1.0
No	30	100	30	100	

addition to noting shorter operative times and lower donor-site morbidity with SMIF, studies reported comparable complication profiles, speech and swallowing outcomes for SMIF and RFFF. According to their analysis, SMIF is a dependable substitute for free-flap reconstruction in certain oral cavity defects<sup>11</sup>. Submental pedicled flaps and RFFF were found to have similar functional outcomes (speech and swallowing) for tongue and floor-of-mouth defects in a multi-institutional retrospective review. However, the authors stressed the importance of careful patient selection and flap sizing because RFFF frequently supplies larger tissue volumes when necessary<sup>12</sup>. These findings are also supported by a number of systematic reviews and larger series: pooled analyses indicate that SMIF results in shorter hospital stays, shorter operating times, and lower overall costs with comparable short-term functional outcomes. According to a review by Mooney et al., in carefully chosen cases, submental artery island flaps preserve functional outcomes while outperforming free flaps on perioperative metrics<sup>13</sup>. Likewise, cost- and morbidity-focused reports have documented reduced hospital resource utilization with SMIF compared with RFFF<sup>14</sup>.

16.7% of RFFF and 13.3% of SMIF patients in our study reported having trouble swallowing liquids ( $p=0.237$ ), while 86.7% vs. 93.3% reported having trouble swallowing solids ( $p=0.670$ ). Although SMIF patients started oral feeding earlier ( $p=0.031$ ), a recent FEES-based study by Karimi et al. (2023) found no significant difference in pharyngeal residue or penetration between SMIF and RFFF at 10 and 30 days. These results compare favorably with the literature<sup>15</sup>.

Additionally, our study's infection rates (RFFF 10% vs. SMIF 16.7%,  $p=0.706$ ) are consistent with multi-center data that indicates donor-site morbidity and wound complications can range from 2% to 10% in forearm free flap procedures<sup>16</sup>. Another important factor is donor-site morbidity. According to our data, there was no sensory loss in either group, and 86.7% of RFFF patients and 100% of SMIF patients had preserved object-holding abilities ( $p=0.112$ ). Research indicates that up to 30% of hand sensory changes occur three months after harvest, although many improve by fourteen months. Forearm donor-site morbidity is still a well-documented problem<sup>17</sup>. Research like Oh et al. (2007)'s long-term functional

outcomes study of RFFF highlights that recovery lasts for a long time after a year<sup>18</sup>. A systematic review from 2021 highlighted the importance of long-term sensory sequelae by quantifying donor-site hypoesthesia in roughly 34% of patients and neuropathic pain in 23%<sup>19</sup>. Free flaps (including RFFF) provided better long-term functional outcomes than pedicled flaps, according to a different systematic review that examined 42 studies. However, it was pointed out that the difference was negligible when pedicled flaps were used for smaller defects<sup>20</sup>. Because allocation was based on defect size, potential confounders such as age, BMI, comorbidities, and sex distribution were considered. Exploratory adjusted analysis confirmed that none of these factors changed the overall interpretation of the results, supporting the internal consistency of the findings despite the non-randomized design.

Overall, our study's lack of statistically significant differences is consistent with the mounting evidence that SMIF is a less complicated and morbid substitute for microvascular free flaps in treating small-to-moderate tongue defects. Because of its adaptability and thin, pliable tissue, RFFF is still the gold standard for larger and composite defects; however, SMIF has clear benefits, such as a shorter recovery period, the avoidance of microvascular anastomosis, and a lower risk of donor-site morbidity. Furthermore, SMIF is especially appropriate for patients with major comorbidities or in environments with limited resources, where extended microvascular procedures carry a higher risk.

## LIMITATIONS

OKarachi has a sizable population overall, but the study's eligible patient pool is much smaller. Only a small percentage of head and neck cancer cases specifically have primary operable tongue SCC that needs to be rebuilt right away; even fewer of these cases fit the stringent inclusion requirements (no prior radiation, no recurrent disease, no significant comorbidities, and defect sizes suitable for SMIF/RFFF comparison). Additionally, oncology patients in Karachi are widely distributed across multiple public, private, and charity hospitals, leading to limited case concentration at any single center. Case availability is further affected by referral patterns, socioeconomic constraints, and treatment preferences.

Multi-center collaboration could indeed increase

recruitment; however, such coordination requires uniform surgical protocols, shared ethics approvals, and standardized postoperative assessments, which were beyond the scope and timeline of the present study. This study therefore represents the realistic maximum recruitment capacity for a controlled, uniform surgical comparison within our tertiary care setup.

## CONCLUSION

Radial Forearm Free Flap (RFFF) and Submental Island Flap (SMIF) both demonstrated similar results in terms of healing, function, and complication rates, making them both dependable choices for tongue reconstruction. For moderate tongue defects, the SMIF is a viable and less invasive option because of its shorter operating time and low donor-site morbidity. SMIF offers a useful solution in carefully chosen situations, but RFFF is still crucial for bigger and more intricate reconstructions. Both methods can improve quality of life and restore function after surgery for tongue cancer if the patient is carefully chosen.

## REFERENCES

1. Krishnatreya M, Nandy P, Rahman T, Sharma JD, Das A, Kataki AC, et al. Characteristics of oral tongue and base of the tongue cancer: a hospital cancer registry based analysis. *Asian Pacific Journal of Cancer Prevention*. 2015;16(4):1371-4.
2. Yu GP, Mehta V, Branovan D, Huang Q, Hashibe M, Zhang ZF, Schantz SP. Improved survival among patients with base of tongue and tonsil cancer in the United States. *Cancer Causes & Control*. 2012 Jan;23(1):153-64.
3. Khan MN, Perez E, Goljo E, Illoreta A, Park RC, Genden EM, Miles BA. The price of free tissue transfer after tongue reconstruction: quantifying the risks. *The Laryngoscope*. 2017 Jul;127(7):1551-7.
4. Larn L, Samman N. Speech and swallowing following tongue cancer surgery and free flap reconstruction-a systematic review. *Oral oncology*. 2013 Jun 1;19(6):SOT-24.
5. Sittitrai P, Reunmakkaew D, Srivanitchapoom C. Submental island flap versus radial forearm free flap for oral tongue reconstruction: a comparison of complications and functional outcomes. *The Journal of Laryngology & Otology*. 2019 May;133(S):413-8.
6. Kerawala C, Roques T, Jeannon JP, Bisase B. Oral cavity and lip cancer: United Kingdom National Multidisciplinary Guidelines. *J Laryngol Otol* 2016;130(suppl S2):S83-9
7. Wang Y, Zhou B, Chen WL, Huang ZX, Chen R. Facial-submental island flap for reconstruction of hemitongue defects in young, middle-aged and elderly patients with early and middle stage oral tongue squamous cell carcinoma. *Head & Face Medicine*. 2022 Dec 5;19(i):39.
8. Gonzalez-Garcia R, Rodriguez-campo FJ, Naval-Gias L, Sastre-p6rez J, Munroz-Guerra MF, Usandizaga JG, Dlaz-Gonz6lez FJ. Radial forearm free flap for reconstruction of the oral cavity.
9. Eker c. Reconstruction with Submental Island Flap in oral cavity Tumors: Advantages and Disadvantages in the current Approach. *J cukurova Anesth surg*. 2022;5(3):404-r2.
10. Chen H, et al. Comparison of morbidity after reconstruction of tongue defects with an anterolateral thigh cutaneous flap compared with a radial forearm free-flap: a meta-analysis. *Br J Oral Maxillofac Surg* (2016)
11. Sittitrai P, Reunmakkaew D, Srivanitchapoom C. Submental island flap versus radial forearm free flap for oral tongue reconstruction: a comparison of complications and functional outcomes. *The Journal of Laryngology & Otology*. 2019 May;133(5):413-8.
12. Paydarfar JA, Patel UA. Submental island pedicled flap vs radial forearm free flap for oral reconstruction: comparison of outcomes. *Archives of Otolaryngology-Head & Neck Surgery*. 2011 Jan 17;137(1):82-7.
13. Mooney SM, Sukato DC, Azoulay O, Rosenfeld RM. Systematic review of submental artery island flap versus free flap in head and neck reconstruction. *American journal of otolaryngology*. 2021 Nov 1;42(6):1031-42.
14. Forner D, Phillips T, Rigby M, Hart R, Taylor M, Trites J. Submental island flap reconstruction reduces cost in oral cancer reconstruction compared to radial forearm free flap reconstruction: a case series and cost analysis. *Journal of Otolaryngology-Head & Neck Surgery*. 2016 Jan;45(1):11.
15. Karimi E, Hashemi Z, Sohrabpour S, Mousavi SM, Yousefi J. Comparison of swallowing disorder in patients with tongue cancer undergoing reconstruction with either a radial forearm free flap or a submental island flap. *Oral and Maxillofacial Surgery*. 2024 Mar;28(1):125-30.
16. Chaudhuri GR. Reliability of Free Radial Forearm Flap for Tongue Reconstruction Following Oncosurgical Resection. *Bengal Journal of Otolaryngology and Head Neck Surgery*. 2015 Aug 1;23(2):57-62.
17. Bagheri SC. Reconstructive oral and maxillofacial surgery. In *Clinical review of oral and maxillofacial surgery* 2008 Jan 1 (pp. 263-302). Mosby.
18. Rieger JM, Zalmanowitz JG, Li SY, Sytsanko A, Harris J, Williams D, Seikaly H. Functional outcomes after surgical reconstruction of the base of tongue using the radial forearm free flap in patients with oropharyngeal cancer. *Head & Neck*. 2014 Jun;36(6):653-61.

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- ryngeal carcinoma. *Head & Neck: Journal for the Sciences and Specialties of the Head and Neck.* 2007 Nov;29(11):1024-32.
19. Khan Z, Saleem M, Khan I, Rahman MF. Functional Outcomes of Tongue Reconstruction After Cancer Extirpation in Different Flaps: Pedicled Versus Free Flaps: A Systematic Review. *Plastic and Reconstructive Surgery–Global Open.* 2025 Oct 1;13(10):e7100.
20. Kamali A, Skogh AC, Nord ÅE, Lundgren K, Jergovic D, Nordenvall LH, Sommar P, Halle M. Increased salvage rates with early reexploration: a retrospective analysis of 547 free flap cases. *Journal of Plastic, Reconstructive & Aesthetic Surgery.* 2021 Oct 1;74(10):2479-85.

CONFLICT OF INTEREST  
Authors declare no conflict of interest.  
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**AUTHORS' CONTRIBUTION**

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: MA, NW, KS, AIB, AW, A  
Acquisition, Analysis or Interpretation of Data: MA, NW, KS, AIB, AW, A  
Manuscript Writing & Approval: MA, NW, KS, AIB, AW, A

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.



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