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Treatment Outcomes Of The Submental Flap In The Surgical Reconstruction Of Oral Soft Tissue Defects

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Abstract:
Background*: Reconstruction of oral and perioral soft tissue defects resulting from benign and malignant lesions, trauma, or tumor resection remains a significant challenge in oral and maxillofacial surgery. The submental flap has emerged as a reliable reconstructive option because of its favorable color and texture match, concealed donor site, reduced surgical complexity, and shorter operative time compared with free flaps. This study aims to evaluate the functional and aesthetic outcomes of the submental flap in the reconstruction of oral soft tissue defects.*
Materials and Methods*: This prospective observational case series was conducted with sixteen patients undergoing reconstruction with a submental flap for orofacial soft tissue defects, who were included in the study. Clinical outcomes assessed included mouth opening, flap viability, donor site complications, surgical duration, and scar aesthetics using the Patient and Observer Scar Assessment Scale (POSAS). Patients were evaluated clinically and photographically during postoperative follow-up.*
Results*: Sixteen patients underwent reconstruction using the submental flap, with a mean age of 45.56 ± 9.47 years and a male predominance (62%). Mean mouth opening improved significantly from 11.25 ± 7.64 mm preoperatively to 30.81 ± 6.93 mm at 3 months postoperatively ($p < 0.001$). POSAS assessment demonstrated satisfactory aesthetic outcomes, although patients rated scar appearance less favorably than observers. Flap necrosis was observed in 13% of cases, while successful flap healing occurred in 87% of patients. Donor site healing was satisfactory in 93.75% of cases, with minimal postoperative complications. The mean surgical duration was 131 minutes.*
Conclusion: *The submental flap appears to be a reliable and versatile option for reconstruction of oral and perioral soft tissue defects, providing favorable functional and aesthetic outcomes with minimal donor site morbidity. Further studies with larger sample sizes and longer follow-up periods are required to evaluate long-term outcomes and oncological safety.*
Key Word: *Buccal mucosa, Facial reconstruction, Orofacial defects, Reconstructive surgical procedures, Submental flap, Surgical flaps, Treatment outcome*

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I. Introduction

Benign and malignant lesions, traumatic injuries, and surgical interventions for tumor resection are among the major causes of facial soft tissue defects and deformities.[1] Reconstruction of oral and perioral soft tissue defects remains a significant challenge in oral and maxillofacial surgery because of the complex anatomical, functional, and aesthetic requirements of the region. Despite the availability of multiple donor sites and reconstructive techniques, there is still a need for an ideal flap that provides satisfactory functional and cosmetic outcomes with minimal donor site morbidity.[2]

Oral cavity cancer accounts for approximately 30% of all head and neck malignancies and is considered the sixth most common cancer worldwide. It commonly affects middle-aged and elderly individuals, with squamous cell carcinoma being the predominant histological type. The presence of cervical lymph node metastasis remains one of the most important prognostic factors associated with poor outcomes in oral squamous cell carcinoma.[3]

Various reconstructive options have been described for the management of oral soft tissue defects, including local flaps, regional pedicled flaps, and microvascular free flaps. Local flaps involve the transfer of tissues adjacent to the defect, whereas distant flaps include free tissue transfer requiring microvascular anastomosis. Although free flaps are considered the gold standard for reconstruction of large and complex defects, they require advanced microsurgical expertise, prolonged operative time, increased hospital stay, and greater financial resources. Intraoral flaps may also undergo fibrosis and contracture, resulting in less favorable

functional outcomes. Nasolabial flaps remain reliable for selected defects; however, they may produce visible facial scarring, particularly in younger patients. [4]

The submental island flap, first described by Martin et al., has emerged as a reliable and versatile reconstructive option for oral and facial soft tissue defects.[5] Modifications in flap design have enabled its use in a wide range of reconstructive procedures while maintaining good predictability and excellent color and texture match. The donor site scar is well concealed within the submental region, and flap harvest is associated with reduced operative time and shorter hospital stay compared with free flap reconstruction.[6]

The submental flap has been used successfully for reconstruction of tongue and floor of mouth defects, buccal mucosa defects, palatal defects, lip reconstruction, nasal reconstruction, hair-bearing skin defects, and soft tissue defects involving the lower face.[6] Depending on its vascular supply, the flap may be used as a pedicled or free flap. Pedicled variants include orthograde and reverse-flow flaps, while free submental tissue transfer has limited indications for intraoral reconstruction.[7]

Another modification includes the bilateral submental flap, which utilizes the bilateral facial and submental vascular supply for reconstruction of bilateral cheek defects. This technique is particularly useful in elderly or medically compromised patients in whom prolonged microsurgical procedures may not be feasible. The flap offers advantages such as rapid elevation, minimal donor site deformity, preservation of masticatory function, acceptable cosmetic outcomes, and early postoperative rehabilitation, especially in patients undergoing reconstruction following surgical management of oral submucous fibrosis.[8]

The submental artery island flap is a versatile flap that can be harvested as a fasciocutaneous, myocutaneous, myofascial, or osteocutaneous flap. It includes skin, subcutaneous tissue, platysma, and adipose tissue, and is vascularized by the submental artery and vein.[9] The submental artery arises from the facial artery and supplies the submandibular region, anterior belly of digastric muscle, and mylohyoid muscle. Variability in perforator anatomy necessitates inclusion of the ipsilateral anterior belly of the digastric muscle and a cuff of mylohyoid muscle to ensure adequate vascularity of the flap.[10,11]

Several modifications of the submental flap have been described to improve pedicle length and arc of rotation, including reverse venous flow drainage, retrograde arterial flow techniques, hybrid flap designs, and free flap transfer.[12] These modifications have expanded the reconstructive applications of the flap for defects involving the oral cavity, face, and neck.

Despite its advantages, concerns regarding oncological safety and possible compromise of cervical lymph node clearance continue to limit the widespread use of the submental flap in oral cancer reconstruction.[13,14] In addition, limited literature is available evaluating both functional and aesthetic outcomes of the submental flap in patients with oral soft tissue defects, particularly in the Indian population. Therefore, the present study was undertaken to evaluate the treatment outcomes of the submental flap in the reconstruction of oral soft tissue defects with respect to improvement in mouth opening, scar aesthetics, flap viability, donor site morbidity, and operative duration. It was hypothesized that the submental flap would provide satisfactory functional and aesthetic outcomes with minimal postoperative complications and donor site morbidity, thereby serving as a reliable alternative to more complex reconstructive procedures in selected patients.

II. Material And Methods

This observational descriptive longitudinal study was conducted in the Department of Oral and Maxillofacial Surgery, Rural Dental College and Hospital, Pravara Institute of Medical Sciences, Loni, over a period of 2 years from April 2022 to April 2024, following approval from the Institutional Ethical Committee (PIMS/RDC/IEC/UG-PG/03-2023). Written informed consent was obtained from all participants prior to inclusion in the study.

Study Design: Observational descriptive longitudinal study

Study Location: This was a tertiary care teaching hospital-based study done in the Department of Oral and Maxillofacial Surgery at Rural Dental College and Hospital, Pravara Institute of Medical Sciences, Loni.

Study Duration: April 2022 to April 2024

Sample size: 16 patients.

Sample size calculation: The sample size was calculated using OpenEpi software (Version 3.0) based on estimation of frequency in a population. Considering a hypothesized frequency of 3.45%, confidence level of 97%, absolute precision of 10%, and design effect of 1, the minimum sample size required for the study was calculated to be 16 participants.

Subjects & selection method: Patients presenting with oral and/or orofacial soft tissue defects reconstructed using a submental flap were included in the study according to the predefined inclusion and exclusion criteria.

Inclusion criteria:
1. Patients undergoing reconstruction of oral soft tissue defects using a submental flap.
2. Patients willing to provide written informed consent and participate in follow-up evaluations.
3. Patients of either gender and all age groups.
4. Patients with primary tumors classified as T1 or T2 lesions with a clinically node-negative neck (N0) according to TNM staging.

Exclusion criteria:
1. Patients reconstructed using flaps other than the submental flap.
2. Patients in whom primary closure of the donor site was not feasible because of inadequate submental skin laxity.
3. Patients with recurrent tumors.
4. Patients unwilling to participate in the study.
5. Patients with significant systemic comorbidities.
6. Patients with previously irradiated necks.

Procedure methodology

After obtaining written informed consent from all participants, data were collected using a structured clinical proforma and questionnaire. Demographic variables, including age and gender, were recorded. Clinical assessment parameters evaluated during the study included mouth opening, scar aesthetic assessment using the Patient and Observer Scar Assessment Scale (POSAS), flap viability and necrosis, donor site complications, and duration of flap harvesting and inset. Mouth opening was measured preoperatively, intraoperatively, and during postoperative follow-up visits. Flap viability was assessed clinically based on color, temperature, and capillary refill, while donor site healing was evaluated for wound dehiscence and salivary leakage. Clinical examinations, postoperative photographs, and patient-based assessments were used for data collection during follow-up at postoperative day 7, 1 month, and 3 months.

Mouth Opening Assessment

Maximum interincisal mouth opening was measured in millimeters using a Vernier caliper from the mesioincisal angle of the maxillary central incisor to the mesioincisal angle of the mandibular central incisor. Measurements were recorded preoperatively, intraoperatively, and postoperatively on the 7th day, at 1 month, and at 3 months.

Scar Aesthetic Assessment

Scar assessment was performed using the Patient and Observer Scar Assessment Scale (POSAS).[15] The assessment consisted of two components:
1. Observer Scar Assessment Scale
2. Patient Scar Assessment Scale

The observer scale evaluated vascularity, pigmentation, thickness, relief, and pliability, while the patient scale assessed pain, itching, color, stiffness, thickness, and irregularity of the scar. Both patient and observer assessments were recorded postoperatively on the 7th day, at 1 month, and at 3 months.

Flap Viability Assessment

Flap viability was assessed clinically based on color, temperature, and capillary refill.[16] Flaps were examined for evidence of partial or complete necrosis during postoperative follow-up. Capillary refill time of 2–3 seconds and normal skin coloration were considered indicative of satisfactory flap viability.

Donor Site Complications

Donor sites were evaluated clinically for wound healing, wound dehiscence, and salivary leakage during postoperative follow-up visits.

Surgical Duration

The duration required for flap harvesting and inset was recorded in minutes using a stopwatch, beginning from flap elevation to completion of flap inset into the defect.

Data Collection

Clinical findings, patient records, intraoperative observations, postoperative photographs, and questionnaire-based assessments were documented in a standardized proforma and entered into a Microsoft Excel spreadsheet for analysis.

Surgical Technique

The patient was positioned supine with the head extended. A pinch test was performed preoperatively to assess skin laxity and determine the feasibility of primary closure of the donor site. An elliptical skin paddle was marked in the submental region with the anterior belly of the digastric muscle included within the flap design. Subplatysmal dissection was performed to identify and preserve the submental artery and vein, which arise from the facial vessels. The flap was elevated along with the anterior belly of the digastric muscle to preserve perforator vascularity. In selected cases, a cuff of mylohyoid muscle was included to facilitate tunneling and maintain vascular integrity.[17] For bilateral cheek reconstruction, a bilateral submental flap design was utilized as described by Gadre et al.[8] A subcutaneous tunnel was created lateral to the mandible to permit tension-free transfer of the flap into the intraoral defect. The flap was then inset intraorally using absorbable sutures.

Statistical Analysis

Data were compiled and analyzed using descriptive and inferential statistical methods. Quantitative variables were expressed as mean and standard deviation, whereas categorical variables were presented as frequency and percentage. Changes in mouth opening over time intervals were compared using a repeated-measures analysis of variance (ANOVA). A p-value of <0.05 was considered statistically significant

III. Result

A total of 16 patients underwent reconstruction using the submental flap during the study period. The mean age of the participants was 45.56 ± 9.46 years (range: 32–61 years). Male predominance was observed, with 10 (62%) male and 6 (38%) female patients (Table 1).

Table 1: Descriptive demographic data of study participants.

PARAMETER	CATEGORY	VALUE
AGE (YEARS)	Mean ± SD	45.56 ± 9.46
	Range	32–61
GENDER	Male	10 (62%)
	Female	6 (38%)
TOTAL PARTICIPANTS	—	16 (100%)

Among the 16 patients, 12 patients underwent reconstruction following surgical management of oral submucous fibrosis (OSMF), while 4 patients underwent reconstruction following resection of buccal mucosa carcinoma (T1/T2 lesions).

Mouth Opening Assessment

The mean preoperative mouth opening (Table 2) was 11.25 ± 7.63 mm. Intraoperatively, the mean mouth opening increased to 40.75 ± 3.67 mm. The mean mouth opening recorded postoperatively was 29.37 ± 6.76 mm on the 7th postoperative day, 30.93 ± 6.94 mm at 1 month, and 30.81 ± 6.93 mm at 3 months (Figure 1)

Table 2. Comparison of mouth opening over time using repeated measures ANOVA.

Time Interval	Mean Mouth Opening (mm)	Standard Deviation	Median
Preoperative	11.25	7.64	10.5
Intraoperative	40.75	3.68	40.0
Postoperative – 7th Day	29.38	6.76	26.5
Postoperative – 1st Month	30.94	6.94	30.5
Postoperative – 3rd Month	30.81	6.93	31.0
F-value			**72.646**
p-value			**<0.001**

Figure 1. Clinical photographs demonstrating bilateral submental flap reconstruction in a patient with Grade III oral submucous fibrosis (OSMF): (A) Preoperative interincisal mouth opening, (B) Marking for bilateral submental flap, (C) Intraoperative mouth opening, (D) Harvested right submental flap, (E) Harvested left submental flap, (F) Inset of bilateral submental flaps into the defect, (G) Extraoral donor site closure, (H) Postoperative follow-up photograph after 1 month, (I) Postoperative interincisal mouth opening, (J) Right buccal mucosa, and (K) Left buccal mucosa

Repeated measures ANOVA demonstrated a statistically significant improvement in mouth opening across the different follow-up periods ($p<0.001$). Pairwise comparison using Tukey–Kramer post hoc analysis (Table 3) revealed statistically significant differences between preoperative mouth opening and all postoperative intervals ($p<0.001$).

Table 3. Tukey–Kramer post hoc analysis for pairwise comparisons of mouth opening following repeated-measures ANOVA.

Comparison	q-value	p-value
Preoperative vs Intraoperative	23.457	<0.001
Preoperative vs Postoperative Day 7	14.412	<0.001
Preoperative vs Postoperative 1 Month	15.654	<0.001
Preoperative vs Postoperative 3 Months	15.555	<0.001

Comparison between preoperative and 3-month postoperative mouth opening using a paired t-test also demonstrated statistically significant improvement ($p<0.001$).

Scar Aesthetic Assessment

The mean observer POSAS score was 14.25 ± 2.20, whereas the mean patient POSAS score was 19.00 ± 3.52. A statistically significant difference was observed between observer and patient scar assessment scores ($p<0.001$), indicating that patients rated scar appearance less favorably than observers. However, the combined assessment demonstrated overall cosmetically acceptable scar outcomes (Table 4).

Table 4: Comparison of Observer and Patient POSAS Scar Assessment Scores

Assessment Scale	Mean Score	Standard Deviation	p-value
Observer Scar Assessment Score	14.25	2.20	<0.001
Patient Scar Assessment Score	19.00	3.52	

Flap Viability

Flap necrosis was observed in 2 patients (13%), while satisfactory flap viability without necrosis was observed in 14 patients (87%). No statistically significant association was found between the underlying diagnosis and flap necrosis ($p=0.466$) (Table 5).

Table 5: Association between diagnosis and flap necrosis after 15 days postoperatively.

Diagnosis	Normal Flap Healing n (%)	Flap Necrosis n (%)	Chi-square (χ^2)	p-value
OSMF Grade III	8 (80%)	2 (20%)	2.55	0.466
OSMF Grade II	3 (100%)	0		

OSMF Grade IV	1 (100%)	0		
Buccal Mucosa Carcinoma	4 (100%)	0		
Total	**14 (87%)**	**2 (13%)**		

Donor Site Complications

Normal donor site healing was observed in 15 patients (93.75%). Wound dehiscence and salivary leakage were each observed in 1 patient (6.25%) (Table 6).

Table 6. Donor site complications

Donor Site Complication	Frequency (n)	Percentage (%)
Normal Healing	15	93.75
Wound Dehiscence	1	6.25
Salivary Leakage	1	6.25

Surgical Duration

The mean time required for flap harvesting and inset was 131.06 ± 5.97 minutes, with a range of 122–150 minutes (Table 7).

Table 7. Time taken for harvesting and inset of the submental flap

Variable	Minimum (min)	Maximum (min)	Mean ± SD (min)
Time Taken for Flap Harvesting and Inset	122	150	131.06 ± 5.97

IV. Discussion

Reconstruction of oral and perioral soft tissue defects remains a significant challenge in oral and maxillofacial surgery because restoration of both function and aesthetics is essential for satisfactory patient outcomes. Various reconstructive options, including local, regional, and free flaps, have been described for the management of these defects. Although free flaps are considered the gold standard for reconstruction of extensive head and neck defects, they are associated with prolonged operative time, increased technical demand, greater resource utilization, and donor site morbidity. Regional pedicled flaps, therefore, continue to play an important role, particularly in elderly patients and in patients with limited medical fitness.[9,18]

The submental island flap has emerged as a reliable and versatile reconstructive option because of its consistent vascular anatomy, proximity to the recipient site, favourable colour and texture match, concealed donor site scar, and relatively simple surgical technique. Since its original description by Martin et al., various modifications and applications of the flap have been reported for the reconstruction of intraoral and facial soft tissue defects.[19] The flap has demonstrated usefulness in the reconstruction of defects involving the tongue, floor of the mouth, buccal mucosa, palate, lips, and lower facial region.[5,20]

In the present study, 16 patients underwent reconstruction using the submental flap. The mean age of the patients was 45.56 ± 9.46 years, with a male predominance (62%). This finding is consistent with the higher prevalence of oral potentially malignant disorders and oral cavity malignancies among males reported in previous studies.[3,14] Most patients in the present study were diagnosed with oral submucous fibrosis (OSMF), while a smaller proportion underwent reconstruction following resection of buccal mucosa carcinoma.

Mouth opening showed significant improvement following surgical intervention and reconstruction with the submental flap. The mean preoperative mouth opening increased from 11.25 mm to 30.81 mm at 3 months postoperatively, with statistically significant improvement observed across all postoperative follow-up intervals ($p<0.001$). These findings indicate that submental flap reconstruction provides satisfactory functional rehabilitation in patients with restricted oral opening. Similar outcomes were reported by Gadre et al., who described significant postoperative improvement in mouth opening following bilateral submental flap reconstruction in OSMF patients.[8] Mehrotra et al. also emphasized the importance of adequate reconstruction in maintaining postoperative oral function and reducing the likelihood of recurrent fibrosis.[21]

Scar assessment using the Patient and Observer Scar Assessment Scale (POSAS) demonstrated generally favorable aesthetic outcomes in the present study. Although patients rated scar appearance less favorably than observers, the overall combined assessment suggested cosmetically acceptable scars. The concealed donor site beneath the mandibular border is one of the major advantages of the submental flap and contributes significantly to improved aesthetic satisfaction. Similar observations regarding acceptable donor site aesthetics and minimal visible scarring have been reported in previous studies evaluating the submental flap in head and neck reconstruction.[22-24]

Flap viability in the present study was satisfactory in most patients, with successful healing observed in 87% of cases. Flap necrosis occurred in 13% of patients, likely related to venous congestion or vascular compromise. Despite these complications, no statistically significant association was observed between flap necrosis and underlying diagnosis. Previous studies have similarly demonstrated high flap survival rates with

relatively low complication rates when careful surgical technique and appropriate patient selection are employed.[20,25,26][18, 23, 35] Gadre et al. reported successful bilateral submental flap reconstruction without major flap necrosis in patients with OSMF.[8]

Donor site morbidity was minimal in the present study. Normal donor site healing was observed in the majority of patients, while wound dehiscence and salivary leakage were each observed in only one patient. These findings are consistent with previous literature demonstrating low donor site complication rates and satisfactory primary closure following submental flap harvest.[7,23,27]

The mean duration required for flap harvesting and inset in the present study was approximately 131 minutes, supporting the relatively straightforward nature of the procedure compared with microvascular free flap reconstruction. Reduced operative time is particularly advantageous in elderly patients and medically compromised individuals, where prolonged anesthesia may increase perioperative risk. Similar advantages regarding shorter operative duration and reduced hospitalization have been reported in previous comparative studies.[6,18]

Despite its advantages, concerns regarding the oncological safety of the submental flap remain, particularly in patients with cervical lymph node metastasis, because the flap is harvested in proximity to level I lymph nodes. To minimize oncological risk, the present study included only patients with clinically node-negative necks (N0). Several authors have emphasized careful patient selection and meticulous neck dissection when considering the submental flap for oral malignancy reconstruction.[7,13,14]

The present study has certain limitations. The sample size was relatively small, and the follow-up period was limited to three months. In addition, the study lacked a comparative group involving other reconstructive modalities such as radial forearm free flaps or nasolabial flaps. Further multicentric studies with larger sample sizes and longer follow-up periods are necessary to evaluate long-term functional, oncological, and aesthetic outcomes of submental flap reconstruction.

V. Conclusion

The submental flap is a reliable and versatile reconstructive option for oral and orofacial soft tissue defects, offering satisfactory functional and aesthetic outcomes with minimal donor site morbidity. Significant improvement in mouth opening, favourable flap viability, and acceptable scar aesthetics was observed in the present study. Owing to its relatively simple surgical technique and shorter operative time, the submental flap serves as an effective alternative to free flap reconstruction in selected patients. Further studies with larger sample sizes and longer follow-up are required to evaluate long-term outcomes and oncological safety.

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