Oncological Safety of Submental Artery Island Flap in Oral Reconstruction - Analysis of 229 Cases

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Abstract Submental artery island flap (SMIF) is gaining popularity as a viable alternative to free flaps in carefully selected oral cavity defects after surgical extirpation of cancers. The current paper looks into the overall efficacy and oncological safety of the flap based on a prospective audit of 229 cases done at a high volume cancer center from October 2004 to September 2012 and concludes that SMIF is an oncologically safe, reliable reconstructive option in carefully selected oral cancers undergoing surgical resections.

Keywords Submental flap · Oncologic safety

Introduction

Surgical treatment of head and neck cancers most often involve radical resections followed by complex reconstructions to restore form and function. Last three decades have witnessed exciting strides in the field of functional soft tissue reconstruction including microvascular surgery. However in high volume, low resource centres, various pedicled flaps continue to play a crucial role. The ablative surgery and immediate reconstruction with a flap has a significant impact on the quality of life of patients. However while reconstructing the oral cavity, compromise on neck nodal clearance is a major concern [1].

Submental Artery Island Flap (SMIF) was first described by Martin and colleagues in 1993 in their search for an ideal flap to restore facial defects with regard to colour, shape and tissue texture [2]. Three years later the same was used in oral squamous cell carcinoma by Sterne et al. [3]. Over the past two decades, this flap has gained acceptance as a reliable and easily available alternative in the reconstruction of oral cavity defects [3–11]. It is an axial pattern skin flap based on the submental artery, a consistent branch of facial artery. Although the anatomical details and functional outcomes have been studied extensively, there are still concerns regarding its safety in oral cancer because sufficient data addressing this issue is lacking in the literature.

In this article, which we believe is the largest case series on Submental Artery Island Flap published so far, an eight year analysis of the survival outcomes of patients treated at our Centre is presented with an aim to establish the oncological safety of this flap.

Materials and Methods

Two hundred and twenty nine (229) consecutive patients of oral cancers treated by wide excision and submental artery island flap reconstruction at the Regional Cancer Centre Trivandrum, India, from October 2004 to September 2012 were studied to assess flap viability and loco-regional control rate. TNM stages of all cases selected were documented. Patients included those with clinically palpable nodes of doubtful oncological significance also. Submental flap was harvested after meticulous dissection and isolation of its vascular pedicle during the neck dissection in all the cases.

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Fig. 1 Schematic diagram of flap design,vascular pedicle and donor site closure

Relevant Anatomy and Flap Technique

Submental flap is an axial pattern skin flap akin to a perforator based flap in the extremity, with a wide arc of rotation. It is based on submental artery, which is the largest and well defined branch of facial artery in the neck. During its course the submental artery gives off intra glandular, muscular (along anterior belly of digastric) and cutaneous perforators. The cutaneous perforators terminate in a sub dermal plexus and supplies almost entire skin of the hemi neck. This subdermal plexus is connected with the opposite submental artery thus allowing for reliable random perfusion of the opposite neck also. Submental vein drains into common facial vein or external jugular vein and stays superficial to submandibular gland. The level of arterial branching and the venous confluence

occurs approximately 1.5–2 cm below the lower border of the mandible.

The patient is positioned supine with head slightly extended and a pinch test done to ensure feasibility of a primary closure of the donor defect. An elliptical skin island is marked out taking care that the anterior belly of digastric lies underneath it. Head is then hyperextended and turned to the opposite side and the dissection carried out either in an anterograde manner from the facial vessels or in a retrograde fashion from the submental vessels. [4] The pedicle is carefully skeletonised taking care not to include lymph bearing fibrofatty tissues. Most of our flaps were chimeric (myocutaneous) in nature and contained anterior belly of digastric and a strip of mylohyoid for additional blood supply to the flap. The flap is tunnelled medial to mandible or lateral depending on the site of the defect. A pedicle length of approximately 5 cm is easily obtained, which was usually sufficient in most of the cases. The length could be further enhanced by ligating the distal portion of the facial artery after the submental artery is given off (along with the corresponding vein) or the proximal portion if a reach towards the infra orbital region is required. We have also employed a modified elliptical design [8] to ensure a dog ear free donor site closure in many of our cases. (Fig. 1) We advice that the surgeon should resort to an alternative plan in situations where the level I nodes are found to be adherent to surrounding tissues intraoperatively. Frozen section of the nodes close to the pedicle can also be done before proceeding with flap harvest. Placing the ipsilateral cut of the ellipse in continuity with the submandibular incision used for the upper neck dissection before committing on raising the skin island helps the surgeon in switching over to an alternative plan if the nodal clearance is unsatisfactory.

Table 1 Demographics, clinical staging and level 1b involvement

Patient demographics		Clinical staging and level 1b involvement	
Variable	Numbers (%)	T staging	Number (%)
Sex	Males – 122 (53.3 %)	T1	32 (13.9 %)
	Females – 107 (46.7 %)	T2	152 (66.4 %)
Age	56.12 +/- 11.7 years (18–85 years)	T3	33 (14.4 %)
		T4	11 (4.8 %)
		Tx	1 (0.4 %)
		N staging	Number (%)
Primary subsite		N0	155 (67.7 %)
Tongue	183(79.9 %)	N1	42 (18.3 %)
Floor of mouth	26 (11.4 %)	N2a	1 (0.4 %)
Buccal mucosa	12 (5.2 %)	N2b	28 (12.2 %)
Lip	1 (0.4 %)	N2c	3 (1.3 %)
Others	7 (3.11 %)	Level I b clinical involvement	
Previous treatment		Yes	28 (12.2 %)
Radiotherapy	29 (12.66 %)	Nil	201(87.8 %)
Chemotherapy	46 (20.19 %)		
Surgery	20 (8.7 %)		

Table 2 Pathological staging, features and adjuvant therapy

Pathological T staging			Pathological N staging		
	Frequency	Percent		Frequency	Percent
T0	6	2.6	N0	177	77.3
T1	99	43.2	N1	23	10
T2	115	50.2	N2b	28	12.2
T3	7	3.1	N2c	1	0.4
T4	2	0.9			
Histology			Margins		
	Frequency	Percent	Free	177	77.3
SCC	222	96.9	Close	50	21.8
Non SCC	7	3.1	Positive	2	0.9
Differentiation			Perineural involvement		
	Frequency	Percent	Nil	167	72.9
WD	63	27.5	Present	62	27.1
MD	144	62.9	Lymphovascular involvement		
PD	13	5.7	Nil	226	98.7
Others	9	3.9	Present	3	1.3
Adjuvant radiotherapy			Adjuvant chemotherapy		
	Frequency	Percent		Frequency	Percent
Nil	118	51.5	Nil	220	96.1
Yes	111	48.5	Yes	9	3.9

Results

There were 122 males and 107 females, with mean age $\pm$ S.D. of 56.12 ± 11.7 years, ranging from 18 to 85 years. Tongue was commonest site (79.9 %) and majority of the patients (80.3 %) presented with a tumour staged T2 or less. Forty six patients underwent neoadjuvant chemotherapy and forty two of them subsequently stage migrated (down staged) to T2 or less. Seventy-four (32.3 %) patients had clinically palpable neck nodes preoperatively, of which twenty eight (12.2 %) had involvement of level Ib. (Table 1).

Marginal mandibulectomy had to be done in fifty one (22.3 %) patients for clearance. The skin paddles of the flaps ranged in size from 3x2 cm to 8x5 cm, with a mean size of 5.8x4.5 cm, largest flap harvested being measured 8x5cm. Flap necrosis was observed in sixteen patients (6.98 %) four

of which (1.74 %) was total and the defect was left to granulate. Persistent hair growth after completion of adjuvant treatment was seen in 11 male patients (9 %). There were no instances of persistent donor site morbidity although we had documented marginal mandibular nerve paresis in 11(4.8 %) of our patients.

Nodal clearance was achieved by a Selective or Modified Radical Neck dissection in 94.4 % of the patients, whereas the remaining 5.6 % with N0 neck status had only level I clearance. Seven (3.1 %) patients required bilateral neck dissection. After pathological examination, fifty two (22.7 %) patients had proven nodal metastasis. (Table 2).

After a median follow up of 51.6 months (ranging from 5.5 to 107.5 months), thirty nine patients (17.03 %) were found to have locoregional recurrence. Twenty one patients (9.2 %) developed recurrence at the primary site and eighteen

Table 3 Recurrence pattern and status of the patients while the study was completed

Recurrence pattern			Status of last follow up		
	Frequency	Percent		Frequency	Percent
Nil	183	79.9	NED	183	79.9
Distant mets	7	3.1	Alive with disease	13	5.6
Local recurrence at flap	9	3.9	Dead of disease	29	12.7
Local recurrence away from flap	12	5.2	Dead of other cause	4	1.7
Ipsilateral nodal recurrence	15	6.6			
Contralateral recurrence	3	1.3			

Table 4 Analysis of variables affecting locoregional recurrence

Univariate analysis	
Variables	<i>p</i> value
Age	0.858
Sex	0.098
Site of primary	0.893
cT staging	0.470
cN staging	0.017
Neoadjuvant treatment	0.403
Post op RT	0.870
Post op CT	1.000
pT staging	0.051
pN staging	0.003
Histology	1.000
Differentiation	0.011
Margins	0.731
Perineural invasion	0.198
Lymphovascular invasion	0.104
Multivariate analysis	
Tumour differentiation	0.05
Pathological node positivity	0.002

(7.8 %) in the neck. Fifteen (7.8 %) recurred in the ipsilateral neck, 12 (5.24 %) of which belonged to the node negative group of patients. Nine (3.93 %) node negative patients recurred in level Ib alone and seven recurred at the flap site. Two among the patients with nodal recurrence had concurrent recurrence at primary site as well. Six of the eighteen nodal recurrences occurred outside the field already addressed. Seven (3.1 %) patients developed distant metastasis. Of the total locoregional recurrences, ten patients (10/39) could be salvaged surgically. (Table 3).

On univariate analysis of variables for locoregional recurrence, statistical significance was found for clinical node involvement (p value = 0.017), tumour differentiation (p value = 0.01), pathological node positivity (p value = 0.003) and pathological T staging (p value = 0.05). Multivariate analysis showed significance for tumour differentiation (p value = 0.05) and pathological node positivity (p value = 0.002). (Table 4).

The overall survival of this series of patients was found to be 97.8 $\pm$ 1.0 % at 1 year, 89.6 % $\pm$ 2.1 % at 3 years and 84.6 $\pm$ 2.7 % at 5 years. The disease free survival amounts to 88.6 $\pm$ 2.1 % at 1 year, 81.8 % $\pm$ 2.6 % at 3 years and 78.1 $\pm$ 3.0 % at 5 years. This rate is comparable with the available survival data on oral cancer patients. (Table 5).

Table 5 Survival probability data

Overall survival			Disease free survival		
Year	Survival probability	Standard error	Year	Survival probability	Standard error
1 year	97.8	1.0	1 year	88.6	2.1
3 year	89.6	2.1	3 year	81.8	2.6
5 year	84.6	2.7	5 year	78.1	3.0

Discussion

The goal of reconstruction in head and neck cancer resection is to achieve adequate functionality and aesthetics by provision of like tissues with minimum morbidity to the donor site thus maintaining quality of life of the patient. The relatively thin skin over the submental area makes it suitable for reconstruction of intraoral defects. Its ready availability and the shorter operative time for its elevation offer obvious advantages over free tissue transfer. The necessity of primary closure after flap harvest limits the size of skin island that can be raised, the largest flap harvested by us being 8x5cm with references of bigger ones in the literature (approx. 15 × 6 cm) [2].

Submental flap in view of its reach and pliability remains an excellent reconstructive option for defects after surgical ablation of oral cancers. It has a reliable and predictable pedicle, and the large caliber of the vessels (approx 2 mm) makes possible its use as a free flap if required, adding to its versatility. The donor site scar is well hidden under the horizontal ramus of the mandible. Although hair growth posed a problem among males patients most of them resolved eventually after the completion of adjuvant radiation therapy. Another complication that can be associated is marginal mandibular nerve paresis which can be avoided by its careful identification and preservation [4, 6–8]. The marginal mandibular nerve paresis (4.8 %) documented in the current series was mild and cosmetically insignificant with no functional deficit.

Oncological safety of submental flap has always been a matter of concern and debate due to its proximity to the submental and submandibular nodes. There is a possibility of inadvertent inclusion of lymphatic tissue harbouring malignant cells into the skin island of the flap or its pedicle [4]. Studies published so far on the oncological safety have largely selected cases with clinically negative nodes [4–11]. Although majority of the patients in our series were N0, we have raised the flap with utmost care in clinically N+ cases as well. All patients without prior neck clearance underwent a formal neck dissection, the type of which depended on the size and site of tumour and site of nodes. While analysing locoregional recurrence, statistical significance was found for clinical node involvement, tumour differentiation, pathological node positivity and pathological T staging (univariate analysis). Interestingly these recurrences were found to be predominantly centered around the level 1a area emphasising the importance of stringent case selection and meticulous lymphatic clearance for which we even recommend usage of operating loupes. Multivariate analysis showed significance only for two factors, tumour differentiation and pathological node positivity. The overall survival and 5 yr. survival figures obtained in our study equals that of the generally accepted survival data for oral cancer (SEER database) [5]. However around 40 % of our patients had some form of treatment like radiotherapy [12 %], neoadjuvant chemo [20 %] or surgery [8 %] before submental flap reconstruction which

might have had a confounding effect. There was also a small number of non squamous cancers of oral cavity [7 cases, 3.1 %] included in the study.

Recent reviews [9] which includes our own earlier publication [4] have confirmed the utility, reliability and reproducibility of this flap. The current article, we believe, throws light on its oncological safety for the first time in literature.

Conclusion

Submental artery island flap harvested after meticulous dissection of its vascular pedicle can be credited as an oncologically safe flap in carefully selected cases of oral cancers, even when a selective or functional neck dissection is performed. It appears to be oncologically safe but should be avoided in patients with palpable or radiologically demonstrable neck node metastases.

Compliance with Ethical Standards

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Conflict of Interest We also dont have any conflicts of interests to declare.

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