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Reconstruction Modalities for Post-Ablation Defects of Buccal Mucosa in Oral Oncosurgery: A Review of Literature

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Abstract: *Carcinoma of buccal mucosa is the most common cancer of the oral cavity in India. Treatment of oral cancer poses unique reconstructive challenges, owing to the dynamic architecture of the oral cavity. Despite current progress in various treatment modalities, over the past 50 years survival rates have not improved drastically. This study provides a detailed insight on each of the options from the myriad of reconstruction modalities that have been instituted for the reconstruction of post-ablation defects which includes free tissue transfer with microvascular anastomosis, regional and local tissue transfer, skin grafting and use of alloplastic materials in a defect based approach for reconstruction of a post ablation defect of buccal mucosa in oral oncosurgery.*

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I. Introduction:

Oro-pharyngeal cancer is the 6th commonest carcinoma in the world. Cancers of the oral cavity are associated with high mortality and morbidity. Although in western countries, the incidence of oral cancers is about 3% of all malignancies, in India, it ranks first at 45%.[1] Cancer of buccal mucosa, lower alveolus and the retromolar trigone are grouped together as cancers of gingivo-buccal complex and can be aptly called as the ‘‘Indian oral cancer’’ as they constitute 60% of all oral cancers in India. Tongue and the floor of the mouth cancers form the bulk of oral cancers in the west.[2]

Intraorally, boundaries of buccal mucosa are the labial commissure anteriorly, pterygomandibular raphe posteriorly and the upper and lower Gingivo-buccal sulcus (GBS) superiorly and inferiorly, respectively.

Relevant surgical anatomy: from within outward, the cheek consists of the mucosa, submucosa, buccinator muscle, buccal pad of fat, SMAS, subcutaneous tissue and skin. Between the buccinator muscle and SMAS layer, branches of the facial nerve run horizontally. The facial vessels traverse lateral to the buccinator muscle in an antero-superior direction. The parotid duct enters the buccal space lateral to the masseter and buccinator muscles, then pierces through the buccinator and opens at the upper buccal sulcus in the region of the maxillary first molar tooth.

The buccal mucosa is related anteriorly with the inner mucosal lining of the upper and lower lips; with the retromolar trigone posteriorly. The extent then continues till the anterior tonsillar pillar and the tonsillar fossa and further towards the posterior pharyngeal wall. The extent superiorly and inferiorly is the mucosa over the respective alveolar processes. For the reconstructive purposes, the buccal mucosa defects may be classified by the extent of their depth. Defects could be of full thickness with or without loss of mandible or maxilla. The reconstructive requirements also vary accordingly. The reconstruction modalities for full thickness cheek defects are out of the scope of this article, however they shall be mentioned, at once, in the forthcoming sections. The reconstruction modalities for primary buccal mucosa defects shall be discussed comprehensively.

Methods and information sources:

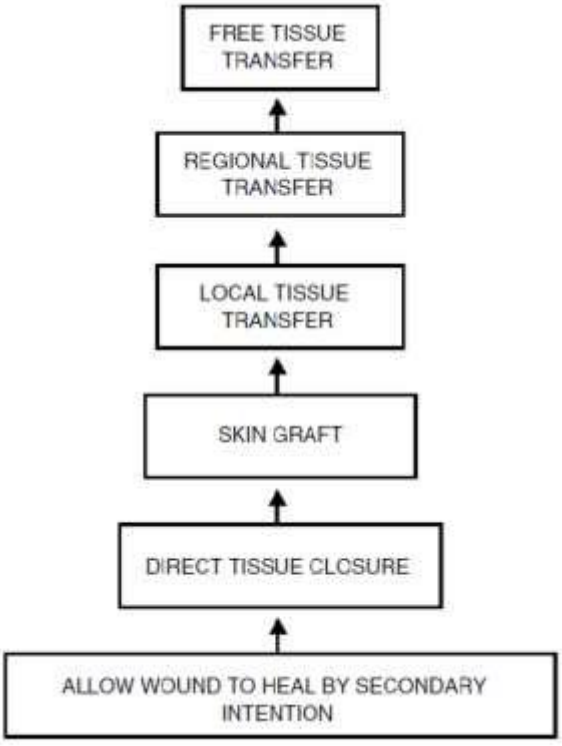
An extensive search of literature published from 01.01.2000 till 31.12.2019 was carried out. Electronic search engines like PubMed, google scholar, Embase, institutional library and the bibliography of studies that were included were included. In addition, only studies that were carried out in humans were looked at. Preliminary screening consisted of 185 studies, out of which 51 were selected. A manual search was performed of the references of each article. All information was sorted and analysed for suitability for inclusion and relevant articles were retained.

Classification of defects of the cheek[3]

Any system to classify post-ablative head and neck defects has to consider the three-dimensional nature of the defect to aid in planning reconstruction and to determine the potential functional and aesthetic morbidity. In all the three planes, there are important structures affecting functional and aesthetic outcomes and hence the plan of reconstruction. Therefore, M.A Kuriakose et al proposed the following classification system which classifies the defect in three different planes, the combination of which gives the exact description of any defect that may assist surgeons to choose a specific reconstructive technique.

1. Thickness of the defect
P: partial-thickness defects – the skin and subcutaneous planes are intact.
F: full-thickness defects – the overlying skin has been resected.
2. Supero-inferior plane
I. Limited buccal defect without bony resection
(a) <3 cm in greatest dimension
(b) >3 cm in greatest dimension
Ii. Minimal bone resection – upper alveolectomy and/or marginal mandibulectomy, no palatal or floor of the mouth defect.
Iii. Defect involving segmental mandibulectomy with or without subtotal maxillectomy below the zygomatic arch.
Iv. Extensive bone defect with segmental mandibulectomy and subtotal/total
Maxillectomy extending above the zygomatic arch.
3. Anteroposterior plane
A. Limited buccal defect without involvement of commissure, infratemporal
Fossa (ITF) or masticatory space.
B. Anterior defect with involvement of commissure ± lip, but not ITF or masticatory space.
C. Posterior defect with involvement of ITF or masticatory space with or without posterior pharyngeal wall defect without commissure involvement.
D. Defect extending from lip to ITF or masticatory space with or without posterior pharyngeal wall.
In this particular study. The reconstruction modalities for p1aa, p1ba, p1ab, p1bb, p2a and p2b defects shall be comprehensively discussed.

Reconstruction modalities for buccal mucosa defects based on "the reconstruction ladder" [5]



1. Free tissue transfer: a free flap contains a mass of tissue, with its vascular pedicle, that is transferred surgically from its native body location to a distant defect recipient site where vessel continuity is restored by

microvascular anastomosis. This free flap is indicated when a large defect is seen with or without bone, vessel, or nerve exposure in an area where local pedicle flaps are unavailable or too small to cover a large defect.[5]

1a. Free radial artery forearm flap.

The objectives in the reconstruction of buccal defects after surgical resection include restoration of function and structural cosmesis. The free radial artery forearm flap (FRAFF) was first introduced by yang et al. In 1981. Nowadays FRAFF is a workhorse in reconstructive head and neck surgery. Some well-known advantages of FRAFF are: a reliable anatomy, long pedicle length, high calibre vessels, suitable thinness and relative sparsity of hair to substitute mobile oral mucosa.[6] buccal reconstruction with FRAFF yields the most favourable outcome in various comparative studies although it takes more time and skills in the operation. The FRAFF usually tolerates the irradiation well and leads to a satisfactory outcome if the pterygoid muscles do not disrupt significantly during surgery. Nonetheless, the thick subcutaneous adipose tissue of FRAFF may cause the bulky flap intraorally and need a trimming procedure later. Some known potential disadvantages of the FRAFF reconstruction method include the donor site morbidity and the masking effect of tumor recurrence beneath the flap. Consequently, the regular follow up by image study is essential. [7]

A bi-paddled variant of FRAFF has also been successfully used as a modality to reconstruct bilateral defects of buccal mucosa using a single donor site to obviate the need for a second donor site. [8]

1b. The antero-lateral thigh flap (ALT)

Since the first report of the anterolateral thigh flap based on descending branch of lateral circumflex femoral artery by song et al. In 1984, because of its large cutaneous area and long vascular pedicle with a suitable vessel diameter with acceptable donor site morbidity, and because it offers a number of evident advantages, it has become one of the most commonly used flaps for the reconstruction of various soft-tissue defects.[9] the anatomy of the flap and the harvesting technique is comprehensively described in the mentioned studies.[10-11]

The flap can be harvested as a thinned skin, fascio-cutaneous, or musculocutaneous flap as indicated in a defect-based scenario. Therefore, by adapting the depth of the defect, the pliable property of the skin can provide reconstruction of the buccal region with a structurally acceptable thin natural contour that meets the aesthetic requirements of this region. Primary defatting of the flap provides a more acceptable cosmetic appearance and functional reconstruction even in the early period of the surgery, and will facilitate easy inset of the flap.[12] potential complications include marginal necrosis, infection, paraesthesia, muscle herniation, traumatic neuroma and weakness of donor limb.[13]

Various modifications of ALT flap have been successfully used to reconstruct complex, multi-site, non-adjacent defects of buccal mucosa and oral cavity with a single donor site flap using chimeric ALT flap, bi-paddled / tri-paddled ALT flap and chimeric bi-paddled ALT flap.[14-15]

1c. Deep inferior epigastric perforator flap (DIEP flap)

This flap is a fascio-cutaneous flap based on the perforators from the deep inferior epigastric artery, a branch of the external iliac artery. It is a reliable alternative to the ALT flap, which provides adequate soft tissue with a large skin paddle. The advantages of the flap being reliable perforators with adequate calibre, obviated need for secondary skin grafting and the bulk it provides. However, it carries a risk of abdominal complications such as wall weakness and hernia and scar.[16]

1d. Transverse rectus abdominis muscle flap (TRAM flap)

The flap includes harvesting of transverse abdominis muscle. According to a level 1 evidence by man et al in 2009, the TRAM flap is a more robust flap than the DIEP flap with an advantage of fewer flap related complications but unfortunately a higher incidence of donor site associated morbidity.[17]

1e. Facial artery myo-mucosal free flap (FAMM flap) [30]

Referring to the reconstructive surgical laws of "replacing like with like", based on the mucosa which is supplied by the perforators which are based on the facial branch of ECA is a myo-mucosal flap known as FAMM flap. A transplanted mucosa which is very much similar to the surrounding buccal mucosa is used in this method. As compared with a non-prelaminated FRAFF, a lower rate of complications is carried by the transplanted mucosa as it is used for feasible restoration of physiological processes of intraoral defects. After being harvested, the FAMM free flap is transplanted in the soft cheek tissues by routing the pedicle through a Para mandibular tunnel on the contralateral cheek. It arrives on the left side of the neck to reach the recipient vessels. These flaps carry the advantage of maintaining the sensitivity and secretion of mucous which in turn facilitates the rehabilitation of oral functions like masticating and speaking.

Visceral mucosal free flaps used for reconstructing the defects of oral cavity are not new. A jejunum flap, gastric flap or a transverse colon flap are transplanted so as to overcome severe xerostomia and trismus, however, persistent peristalsis, risk of peptic ulceration, excessive folding, mucous secretion and poor durability

have been taken away from the patient satisfaction when used for oral reconstruction. These flaps are not suited for the patients complaining frequently of a disagreeable odour or taste and patients having a history of major abdominal surgery or disease. [31 32 33]

1.Regional and local tissue transfer

The flap performs the direct transfer of tissue. It brings the blood supply; it is placed to cover the defect and it is being raised based on the pedicle. Now the flap does not depend on the pedicle, so the blood vessels grow into the flap, inserting the flap in the defect.

2a. Pectoralis major myo-cutaneous flap (PMMC) [18 19 20 21]

Being the standard of care, the free flap uses the microvascular technique but resources in the developing world and availability of expertise has limited its use. Therefore throughout the world the workhorse for head and neck construction is PMMC.PMMC being based on the descending pectoral branch of thoraco acromial artery , it sports advantages like optimum pedicle length, a robust vascular supply, a relatively easy learning curve for surgeons , an adequate bulk and skin paddle surface area and when inset in the oral cavity it has rewarding reach . Hence in head and neck reconstruction it holds unmatched acceptance.

PMMC, which is counted in primary or medium to large defects of buccal mucosa, has cases with microvascular reconstruction in a salvage reconstruction setting and is contraindicated.

Because of very small defects of buccal mucosa (due to its bulk) and reaching above the level of zygoma, PMMC is contraindicated in reconstructions. A complication rate of 17-63% with the flap is suggested by the literature of a level 3 evidence. For composite defects of buccal mucosa with large labial commissure defects, a bi- paddled modification of PMMC has also been recommended.

2b. Nasolabial flap [22 23 24]

The nasolabial island flap can be used reliably for buccal mucosal defects reconstruction based on superiorly or inferiorly on the subcutaneous blood supply from the transverse angular and facial vessels. For 2 reasons the flap has been proved reliable. Firstly, the whole area is abundantly supplied by the dermo-subdermal plexus. Secondly, ensuring good perfusion to the most distal parts of the flap, this vesicular plexus may exhibit a degree of axiality and is not haphazard. On the transverse branch of maxillary artery this flap can be placed even in the cases where facial artery is sacrificed. In the medium sized defects of buccal mucosa primarily or composite defects which involve 1/3 rd. of ipsilateral lip commissure, an advantage is offered by these flaps by increasing the arc of rotation than most of the local flaps. Extensive composite defects of buccal mucosa and full thickness cheek defects are contraindicated. Unavailability in case of extensive resection, possible compromised blood supply, limited size and a scar over the face are included in the disadvantages. For extensive defects of buccal mucosa with lip commissure defects, the nasolabial flap and PMMC are combined and its use has been published in the literature.

2c. Submental flap [25 26]

Being based on the submental branch of facial artery, this flap has two patterns of submental island flaps which are used after the cancer ablation for the reconstruction of buccal defects. The two patterns are: the facial-submental artery island flap and the reverse facial-submental artery island flap. In cases such as Defects of lower gingiva-buccal sulcus (GBS) which do not exceed an area of 15x8 cm2. A minimal donor site morbidity and a good reach is offered by this flap. The oncological safety of the flap has been questioned by the authors over time due to the involvement of fibro-fatty tissue which, as a part of level I lymph node station in the neck dissections, is usually cleared. For composite or full thickness defects of buccal mucosa, use of bi-paddled submental flaps has been published in the literature, with rewarding results.

2d. Temporalis flap [27 28]

Being based on the branches of deep temporal artery, literature has been published on the use of temporalis myofascial flap for the reconstruction of defects of medium sized buccal mucosa, with variable reliability. After the flap has been harvested, it can be tunnelled and, through the retro-molar trigone, it can be brought into the oral cavity. This flap is not used frequently due to the risks associated with it. The bulk which is required for a buccal reconstruction is lacking in this flap. Fibrosis of muscle causing postoperative trismus is highly associated with this flap.

Other risk factors include potential compromise of blood supply in case of a large resection and temporal hollowing deformity, difficult inset in a dentate patient, potential injury to zygomaticofacial nerve.

2e. Infrahyoid flap [29]

The infrahyoid flap is a reliable flap. For the reconstruction of the buccal mucosal defects, it provides a suitable bulk of non-hair bearing skin. It is based on the superior thyroid branch of the external carotid artery

(ECA) which provides cutaneous perforators to overlying skin. This flap must be thoroughly planned as disruption of the blood supply of the overlying skin may take place if the subplatysmal flap is elevated. The disadvantages of the flap include size, reach and a scar on the neck. In cases where prolonged surgery is not advisable or a free flap is not feasible for any other reason, this flap is considered to be a good option.

2f. Buccinator Myo-Mucosal flap with Buccal fat pad [34]

For the reconstruction of medium sized defects of buccal mucosa anterior to Stenson's duct, this flap is indicated. The flap comprises posterior buccal mucosa and buccinator supplied by the facial artery, which may be harvested and trans-positioned anteriorly on the ipsilateral defect. The ipsilateral pedicled buccal pad of fat is used to reconstruct the posterior defect. These flaps provide advantages like low morbidity, ease, the capability to undergo re-epithelization within a few weeks, intraoral harvest and relatively fast surgery. The main disadvantage for these flaps is that they can only be used for certain defects due to their relatively low mobility. Mostly the oral cavity mucosal defects.

2g. Cervical pedicle flaps

A case series of 130 cervical pedicle flaps which included 47 sternocleidomastoid flaps, 53 Infrahyoid myo-cutaneous flaps and 31 platysma flaps was published by Zhao et al in 2001.

Partial necrosis of the skin paddle in 7 cases and complete necrosis in 5 cases were reported among 131 patients. The reported success rate was 89.4%,92.5%, and 90.3%, respectively for the 3 types of flaps.

Literature is filled with mention of flaps which are widely recognised and used in head and neck reconstruction. These are; Forehead flap, Supraclavicular flap and extended supra-clavicular flap, Hatchet flap, deltopectoral flap, malar posterior auricular-cervico flap and rhombic flap.

For full thickness defects of cheek, malar cheek and midfacial cutaneous defects, aforementioned flaps have been used extensively according to reviewed articles for the publication. Thus, providing these flaps out of the range of this article.

Buccal pad of fat for reconstruction of buccal mucosa defects

In 1977, for the closure of oronasal and oroantral communications secondary to oncologic reactions the pedicled buccal fat pad flap was described. To cover defects Ranging in diameter from 1 to 4cm, the buccal fat pad covered with a split thickness skin graft was studied in four patients. In 1983, the use of the buccal fat pad as a free graft in the oral cavity was described by Enderlin 1986, Tiedeman et al showed that within 2 to 3 weeks the pedicled buccal fat pad flap is epithelialized. Hence, a skin graft was not needed.

The buccal fat pad derives its blood supply from the deep temporal and buccal branches of the maxillary artery, from the transverse facial branch of the superficial temporal artery, and from unnamed branches of the facial artery. The mean thickness of buccal fat pad is 6mm, with a mean volume of 10 ml and an approximate weight of 9.3g. This flap can cover defects of small to medium size with a diameter of about 4cm. For reconstruction of buccal mucosa defects with buccal pad of fat, multiple case series were performed by various authors with rewarding results.

Reconstruction of defects of buccal mucosa of small or medium size with a diameter of less than 4cm was done adequately. Small cheek depressions and flap retraction were some of the reported complications. Complete epithelialization of the flap takes about 3-4 weeks and in about 4 weeks the sensations of the reconstructed area are recovered.

Reconstruction is not influenced by the radiotherapy. Previously radiated beds can also be used for this flap. Its main advantages are:

1) This flap is simple to use and it's also quick.
2) This flap can be used with patients who are already under local anaesthesia.
3) No visible scars are left.
4) Low morbidity is seen.
5) Low failure rate.
6) Patients are comfortable with this procedure.
7) Other pedicled flaps are also associated with this flap.

Skin Grafting for reconstruction of buccal mucosa defects

Skin grafts can be gathered from drum dermatome, air/electric powered dermatomes or by free cutting, also known as humby knife, for the reconstructed area of oral cavity. Size of defects determines the width of the grafts. Oral cavity grafts are usually of medium thickness i.e.: 0.016 - 0.018 inches. The dermal side of the graft must be placed downwards and the recipient bed should be in contact with it after the graft has been harvested. Once the graft is inserted ,3-0 chromic sutures keep the graft in place tacked on the underlying muscles. The graft is sown such that the mucosal edges are overlapped by the edges of the graft, known as pie-crust fashion. A 3-0 vicryl suture is used to tack the edges of the graft, and alternate sutures are left long. The bolster dressing

is not taken down for 5-7 days, during this time, the graft is most vulnerable to shear forces and it has not developed its own blood supply. The dressing can be taken down after 5 days and the sutures can be cut.

When the minimal bulk is required, split thickness skin grafts are best employed and the tethering and scarring is prevented by the epithelial covering. Reconstruction of defects of various sites in the oral cavity including defects arising from buccal mucosa resections, maxillectomy causing buccal mucosa defects, retromolar trigone and floor of the mouth, can be done by skin grafts. History of previous radiation in the head and neck during a skin graft in oral cavity is the basic contraindication. A well-vascularized tissue is used for a patient with a history of previous radiation, such as FRAFF or a pectoralis major flap. Specifically, the STSG fails, if the radiated bone is exposed. Full cheek defects or extremely large resections are not the best restoration options where skin grafts may be used as here, the bulk is desired to aid function after the repair.

II. Use of Alloplastic Materials For Reconstruction

- PGA WITH FIBRIN GLUE [47]

Yonezawa et al have reported that the use of PGA sheets and fibrin glue causes early epithelialization in experiments in rabbits. In the present study PGA sheets and fibrin glue seemingly caused early epithelialization and reduced pain. Products from animal tissue, such as fibrin glue, carry a risk of blood-borne disease but have turned out to be successful. The use of PGA sheet patch grafts attached with fibrin glues is effective & provides good pain control for patients with large open wounds after mucosal resection of oral or oro-pharyngeal SCC.

- HUMAN AMNIOTIC MEMBRANE [49]

Human amniotic membrane in reconstruction of oral cavity defect can be a very useful alternative as it helps in proper reconstruction, post-operative function and aesthetics. Clinical acceptability and applicability of HAM can increase as compared to other graft materials as it will be reliable, available and easily affordable option for surgeons and patients.

- COLLAGEN MEMBRANE [50]

Collagen membrane is easily available, its application is simple and easy and tolerance of membrane by oral tissues is good with no adverse effects or problems with donor site healing.
There is no need to perform a second operation for obtaining a graft or detachment of the pedicle.

- ACELLULAR DERMAL MATRIX [51]

ADM grafts are safe and effective with a success rate of 94.4% where it was replaced with new mucosa-like tissues.

- HYPERDRY AMNIOTIC MEMBRANE [48]

It can be used as a dressing only for patients who are not indicated for autogenous skin grafting as it does not fulfil all requirements of an ideal autograft & needs more
biological activities than other materials, such as exogenous collagen products.

III. Conclusion:

In conclusion, satisfactory appearance and oral functions can be achieved by meticulous reconstruction of buccal mucosa defects. With improvements in the microsurgical reconstructive technique, free tissue transfer has undergone evolutionary changes for reconstruction of buccal mucosa defects. Local flaps however remain the workhorse for reconstruction of these defects in majority of centres. With the myriad of modalities available at disposal, the authors advocate for a defect-based approach for choosing the most suitable reconstructive modality.

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