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Review Article

Reconstruction of Oral Cavity Defects

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INTRODUCTION

Reconstruction of oral cavity defects must maximize residual function of remaining tissue. The reconstructive surgeon should have the ability to tailor the reconstruction according to the size of the defect and general medical status of the patient. The reconstructive ladder is a useful paradigm to conceptualize different types of reconstruction. Free tissue transfer has allowed reconstruction of massive defects.

ANATOMY

The oral cavity extends from the cutaneous-vermillion junction of the lips anteriorly to the anterior tonsillar pillars posteriorly. Superiorly, the posterior border is the hard palate and soft palate junction while inferiorly, the limit is the circumvallate line of the oral tongue. The subsites of the oral cavity include the upper and lower lips, the oral tongue (anterior 2/3), floor of mouth, retromolartrigone, upper and lower alveolar ridges and gingiva, buccal mucosa, and hard palate (Figure 1).

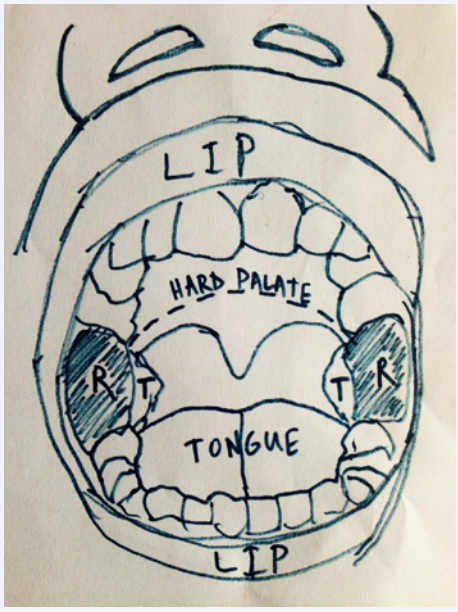

Figure 1 Anterior schema of the oral cavity. R=retromolartrigone. T=tonsil. Dotted line represents junction between hard and soft palate and is the boundary between the oral cavity and oropharynx superiorly.

Functions of the oral cavity

The oral cavity is the entrance to the alimentary tract and thus plays a crucial function in multiple phases of digestion. The lips provide oral competence, but also help with speech production, playing instruments, and human interaction such as smiling and kissing. The buccal mucosa and underlying buccinator muscle force food between the masticatory interfaces of the teeth. The tongue, in addition to harboring chemosensory organs contributing to taste, also propels food posteriorly to begin the swallowing process. The hard palate separates the oral cavity from the nasal cavity. Finally, the entirety of the oral cavity contributes to sound modulation.

General principles of oral cavity reconstruction

The majority of defects of the oral cavity arise primarily from trauma and oncologic resection of oral cavity tumors. Given the complex anatomy of the oral cavity and the multitude of functions it provides, it is no surprise that even minor disturbances in the anatomy of the oral cavity can lead to functionally and psychologically frustrating consequences for patients. Lip defects often lead to embarrassing drooling, while palatal defects allow regurgitation of food into the nasal cavity. Loss of tongue tissue may result in articulation difficulty and/or inability to effectively propel food boluses safely into the oropharynx. With this in mind, the reconstructive surgeon must strive to repair defects while maximizing residual function.

In addition to maximizing residual function, the surgeon should close through-and-through defects of the oral to prevent fistulas that allow egress of saliva into the neck. Digestive enzymes can cause catastrophic erosion of great vessels or flap pedicle vessels with life-threatening hemorrhage or devastating loss the reconstructive flap. In addition any reconstruction should decrease the risk of postoperative aspiration and not lead to airway obstruction and respiratory distress. Another general

goal should be to best recreate the aesthetic appearance of the lower third of the face which includes the anterior subunits of the oral cavity, specifically the lips.

The idea of a reconstructive ladder is useful in formulating surgical plan. The reconstructive ladder is a hierarchical progression of reconstructive options, ranging from simple to complex. Rather than a prescription for treatment, the reconstructive ladder should be viewed as a conceptualization of reconstructive techniques; the choice of what kind of reconstructive surgery must take into consideration the health and desires of the patient, the resources and technical skills of the surgeon, and even the prognosis or need for monitoring in advanced cancer cases. For example, an 87 year-old patient with dementia and a through-and-through defect of the hard palate might benefit greatly from local flap closure of the oronasal fistula, obviating the need to frequently manipulate an obturator (which might even become an aspirated foreign body).

Reconstructive options

Healing by secondary intention is an excellent option, especially for small defects in areas that rapidly mucosalize. For example, small defects of the hard palate mucosa are often left to quickly remucosalize following tumor extirpation. Even moderate defects following resection of tonsil cancers via transoral robotic surgery show excellent healing and excellent functional results [1,2].

Primary closure is simple and preferred for smaller defects in area where soft tissue is easily advanced together without fear of excessive tethering. Defects of about 30% of the oral tongue are best closed primarily, as this shows superior function compared to placement of flaps [3]. Contrast this with a similar defect in the buccal mucosa, where primary closure may lead to trismus and limitation of oral intake.

In cases where moderate-sized defects may cause tethering with primary closure, grafting with split thickness skin is a time-honored method of reconstruction. It has even been applied to massive defects of the oral cavity [4,5]. However, skin grafts heal best with bolsters, which can sometimes be difficult to place intraorally. A cellular dermis has also had extensive application in oral reconstruction, but carries the stigma of cadaveric tissue. Its use has expanded exponentially in the head and neck. It may carry the advantage of allowing early vascular in growth [6].

Locoregional flaps offer vascularized tissue to reconstruct defects where more bulk is desired than achievable with skin grafting. Myriad techniques have been described. Examples include the supraclavicular artery island flap, the submental artery island flap and the facial artery myomucosal flap [7-13] (Figure 2).

Microvascular free flaps offer an incredible amount of tissue bulk and variety. Free flaps can provide considerable skin, bone, fat, and muscle. A full exploration of microvascular reconstruction of the oral cavity is beyond the scope of this article. Several will briefly be mentioned. The fibula free flap provides excellent bony stock with a reliable skin paddle supplied by the peroneal artery (Photo 1) [14]. Its harvest is straightforward and can occur

Figure 2 Supraclavicular artery island flap. Reliable donor tissue can be harvested on superficial branches from the transverse cervical artery. Dotted line shows proposed incisions for harvest of this flap.

Photo 1 Fibula flap. An elliptical skin paddle is harvested along with the underlying fibula bone, both of which are supplied by the peroneal artery and its venae comitantes.

simultaneously with tumor extirpation. The radial forearm free flap, first described in Chinese literature in the 1980s, is a skin and fascial flap based on the radial artery and its venaecomitantes. The anterolateral thigh flap, based on the descending branch of the lateral circumflex artery, supplies a large amount of skin and has the advantage of supplying muscle bulk if needed (the surgeon can include a variable amount of vastuslateralis muscle should soft tissue bulk be desired) [15]. This flap has largely replaced the venerable rectus abdominis free flap, based on the deep inferior epigastric artery, at our institution because functional morbidity is much lower. The subscapular system of free flaps, including the lateral scapula border based on the circumflex artery and the scapula tip flap based on the angular artery, offer excellent reconstructive options, especially for palate and maxillary defects (Photo 2) [16].

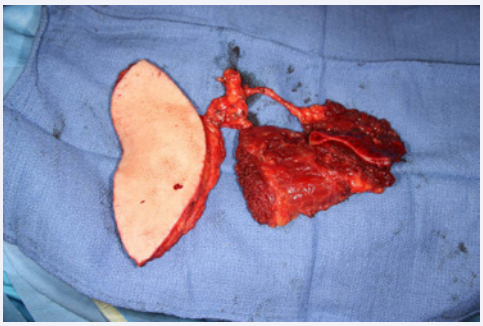

Photo 2 Scapula free flap. A large amount of skin and bone can be harvest based on the subscapular system of vessels. There is generous freedom of motion of the individual soft tissue elements, making reconstruction of complex defects easier.

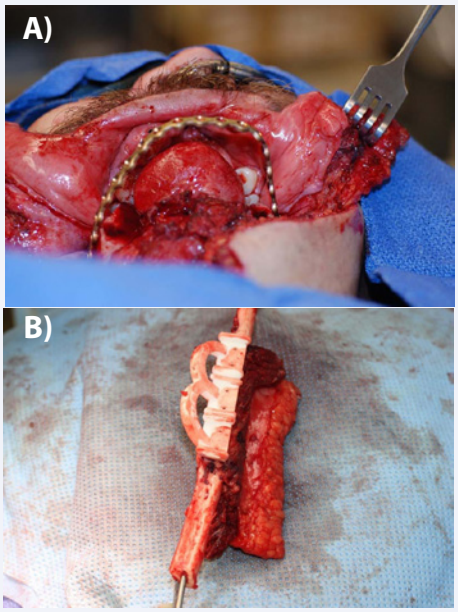

Figure 3 Anterior segmental mandibular defects. A. The gap in bone lost is spanned by a titanium reconstruction plate to which a fibula bone flap will be secured for reconstruction. B. A cutting guide is depicted here secured to the fibula, which guides the sagittal saw cuts to precisely create angulations in the fibula bone to reapproximate the contour of the lost mandibular segment.

CONSIDERATIONS BY SUBSITE

Lips

Reconstruction of lip defects from tumor or trauma requires meticulous planning to attain good functional and cosmetic results. The model reconstruction would result in a lip that maintained sensation, maintained a muscle function that could create a tight seal for oral continence of food products and saliva, provide a space or sulcus that would accommodate dentures or other prosthesis, and is aesthetically pleasing with attention to recreation of the white roll or vermillion cutaneous junction. Since it is not feasible to usually accomplish all of these goals during reconstruction, prioritization is important, with restoration of oral competence being at the top of the list. When analyzing lip defects, the surgeon will tailor the reconstruction based on the defect location and subunit involvement, size, and laxity of surrounding tissue.

Figure 4 Anterolateral thigh free flap reconstruction of a ventral tongue defect.

Partial thickness defects of the mucosa at the vermillion can usually be managed with advancement of local labial or buccal mucosa or V to Y advancement for small lesions. Bipedicled visor type flaps from the labial mucosa of opposing lip or lip switch/cross lip mucosal flaps, and can be used for larger defects. Small full thickness vermillion defects can be reconstructed with advancing adjacent vermillion after making full thickness horizontal releasing incisions along the vermillion cutaneous junction. Another option is to convert the vermillion defect into a full thickness wedge through the cutaneous lip and close primarily. Extensive full thickness vermillion defects can be reconstructed with ventral tongue myo cutaneous flap that is attached to fill in the mucosal defect with secondary division and inset of the flap. Another alternative for full thickness vermillion defects includes the Facial Artery Musculomucosal (FAMM) flap. It is an axial flap based on the facial artery that includes buccal mucosa, submucosa, and small varying bulk of buccinator muscle.

The reconstruction of the upper and lower lips is best approached by analysis of the size of the defect and subsites violated. The upper lip consists of a central philtrum subunit and two lateral trapezoid shaped subunits. The lower lip consists of a single subunit. The defects involvement of specific subunits and oral commissure affects the reconstruction strategy. In general, primary closure can be accomplished in the upper lip for lateral defect that encompass one third of the lip and no involvement of the commissure. Lower lip defects of one half without involvement of the commissure can be closed primarily. Defects involving up to two thirds are usually amenable to closure using local pedicled rotation flaps from the opposite lip which include the Karapandzic labioplasty, the Abbe cross lip flap, and the Estlander cross lip flap. For defects that involve over two thirds of the lips, cross lip flaps can be combined with lateral advancement flaps that incorporate laxity of cheek tissue such as Burrow, Bernard, Webster, or Dieffenbach or inclusion of nasolabial transposition flap. If lateral cheek laxity is not available then regional flaps such as the pectoralis myocutaneous flap or free flaps such as the radial forearm flap can be utilized.[17]

Hard palate

The primary goal of reconstruction and rehabilitation of the

hard palate defects from trauma and oncologic maxillectomy defects is to separate the sinonasal and oral cavity. Also, anterior defects of the palate can lead to loss of projection of the midface. Traditionally, these defects have been treated with prosthetic obturation after lining the defect cavity with a split thickness skin graft for exposed bone to restore speech and swallowing functions. For larger defects and in patients who do not have adequate dentition of residual surface area of the palate to support an obturator, local flaps such as the buccal fat pad flap or facial artery myomucosal advancement flaps are additional options. Finally, microvascular free flaps are being increasingly used. These have the advantage of providing bony structure to maintain projection of the midface.

Okay et al created a classification system to guide reconstruction of palatal defects with surgery and prosthetic rehabilitation [14]. They proposed that defects involving the alveolus posterior to the canine or the central hard palate with ipsilateral canine and contralateral teeth preservation could be reconstructed with soft tissue flaps (e.g. radial forearm) and standard prosthetic obturation due to the support provided by the remaining palate and dentition. However, they found subtotal and total maxillectomy defects yielded poor results with standard prosthetic obturation due diminished support from fewer dentition, reduced arch size, and deficient palate and recommended osteocutaneous free flaps with possible osteointegrated implants for eventual prosthetic attachment.

Cheek

Superficial and partial thickness defects of the buccal mucosa from oncologic resection can be conveniently and expeditiously repaired with split thickness skin grafts. Unfortunately most buccal carcinomas present at advanced stage because of limited natural barriers to tumor spread in the cheek and result in larger full thickness or composite defects involving the mucosa, muscle, external skin, and adjacent bony structures of maxilla and mandible. Flap reconstruction, whether from locoregional flaps such as the submental artery island flap or even free flaps, should be inset with the mouth in maximal opening to prevent debilitating trismus. Reconstruction of soft tissue only defects can be accomplished with regional myocutaneous flaps (i.e., temporalis, pectoralis major) or free flaps (i.e., radial forearm). Composite defects that include soft tissue and bone can be reconstructed with osteocutaneous free flaps (i.e., fibula, scapula, iliac crest free flaps).

Retromolartrigone

The retromolar trigone is a pyramidal shaped region with the base extending across the posterior mandibular alveolus from the distal surface of the last molar and apex at the maxillary tuberosity. Laterally, it extends along the surface of the mandibular ramus to the coronoid process. The medial limit blends with the anterior tonsillar pillar. The mucosa in this region is tightly adherent to the underlying periosteum of the ascending ramus, thus carcinoma often invades the periosteum of the mandible early and readily. Most of the lesions in the retromolar trigone present at advance stages and encroach on the soft palate and tonsillar subsites of the oropharynx leading to larger oncologic defects for adequate soft tissue and bony margins. Split thickness skin grafts can be used for small defects from early stage tumors. Larger soft tissue only lesions that involve subsites of the oropharynx can be reconstructed with a region temporalis or pectoralis major flap. When oncologic resection results in a bony defect, an osteocutaneous free flap provides a better reconstruction option if the defect is large. Smaller defects can be grafted with cancellous bone.

Alveolus

The reconstruction options for the oncologic or traumatic defects of the alveolus depend on the defect size and degree of mandibular resection and or deficiency. Small defects of the maxillary alveolus can be reconstructed with local rotational flaps from the palate, split thickness skin grafts or healing by secondary intention. Marginal mandibulectomy defects can be reconstructed with split thickness skin grafts. Small segmental defects of the lateral/posterior mandible can be reconstructed with a reconstruction bar and soft tissue from either a regional (pectoralis major) or free flap (radial forearm). However, segmental defects of the anterior mandible are best reconstructed with osteocutaneous (e.g. fibula) free flaps that can later support dental implants (Photos 3A and 3B).

Oral tongue

The oral tongue includes the mobile portion anterior to the circumvallate papillae and is important for articulation of speech, taste, and participation in the oral phase of swallowing. Partial glossectomy defects from early stage cancers can be reconstructed with primary closure, healing by secondary intention or split thickness skin graft. Larger defects that involve the floor of mouth, hemiglossectomy, subtotal, or total glossectomy are better reconstructed with a myocutaneous region (pectoralis major) or free flaps. Consideration must be given to the functional status of the residual tongue—reconstruction of extensive defects leaving minimal functional tongue tissue (ie near-total glossectomy) often provide insufficient posterior food bolus propulsion to safely move food over the larynx, which leads to aspiration. In these cases, laryngeal suspension is an important maneuver that has been shown to improve the functional status of glossectomy patients [18]. Advanced oral tongue cancers that have mandibular invasion require a composite resection that results in soft tissue and bony defect that can be reconstructed with an osteocutaneous free flap.

Floor of mouth

The floor of mouth extends from the lingual aspect of the mandibular alveolar ridge to the ventral surface of the tongue. Early stage cancers isolated to the floor of mouth can be reconstructed with a split thickness skin graft on healing by secondary intention. Lesions that extend into the root of the tongue require partial glossectomy and can be reconstructed with a combination of split thickness skin graft with primary closure if small but may require a regional flap or free flap (Photo 4). Advanced cancers that invade the mandible will result in a segmental mandibular defect after a composite resection and usually are reconstructed with an osteocutaneous free flap due the central mandibular defect.

Dental considerations

True functional reconstruction of oral cavity defects is

incomplete with restoration of the masticatory interfaces in those patients who can swallow. Adequate restoration of alveolar sulci is sometimes sufficient to allow placement of dentures. For patients with adequate resources, dental implantation is an attractive option provided the mandible reconstruction has adequate bony stock to support implants. Some institutions favor immediate dental implantation at time of free flap mandible reconstruction. Close coordination between the head and neck reconstructive surgeon and the prosthodontistis important [19,20].

SUMMARY

Reconstruction of oral cavity defects can be challenging due to the need for preservation of function and recreation of the aesthetic appearance of the lower third of the face. Oral cavity defects whether be from oncologic resection or trauma can be characterized by their subsite. The surgeon will then consider the original function, size, location, soft tissue and or bony involvement of the defect and refer to the reconstructive ladder. While the advancement in microvascular free tissue transfer has revolutionized head and neck reconstruction, the surgeon would be wise to implement simpler and more expedient techniques when available and appropriate and conserve more complex procedures as part of a contingency plan.

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