TITLE: Reconstruction of the Oral Cavity
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RESIDENT PHYSICIAN: Michael Underbrink, MD
FACULTY PHYSICIAN: Anna Pou, MD
SERIES EDITORS: Francis B. Quinn, Jr., MD and Matthew W. Ryan, MD

Introduction

Reconstructing the oral cavity is often a difficult challenge for the otolaryngologist. It is important not only to restore cosmesis, but also to restore preoperative function. Understand the anatomy of the oral cavity as well as the functional capacities of its various subunits is required to achieve good results. It is also important to consider the health status of the patient as well as the overall defect when considering options for reconstruction. Various reconstructive options are available to the head and neck surgeon depending on the nature of the defect. These issues will be reviewed in the following pages.

Anatomy

The oral cavity extends from the vermilion of the lips to the junction of the hard and soft palate superiorly. Inferiorly, it extends to the line of the circumvallate papillae of the tongue. It includes the lips, upper and lower alveolar ridges, buccal mucosa, retromolar trigone, hard palate, floor of the mouth and the anterior two thirds of the tongue. Furthermore, each of these structures is important in the complex functional capacity of the oral cavity. The oral cavity is important for speech, mastication, bolus preparation, bolus manipulation and deglutition. Each structure within the oral cavity contributes to its overall function and must be considered for adequate return of function following reconstruction.

Functional Considerations

For reconstructive purposes the functional characteristics of each of the subunits, which make up the oral cavity, should be considered. The *oral sphincter* participates in speech, mastication and deglutition. It provides a watertight closure in bolus preparation and prevents the escape of saliva. The *alveolar ridges* are covered with thin, tightly adherent mucosa. They are elevated above the floor of the mouth and are bordered by the lingual and buccal sulci, which serve to direct the flow of saliva and collect food during bolus processing. The *floor of the mouth* is important to allow unrestricted mobility of the oral tongue. It also collects saliva and food during bolus preparation. The *oral tongue*, or mobile tongue, participates in speech and

bolus manipulation in preparation for deglutition. The mobility of the tongue is paramount to its function as it allows for articulation of speech, and it should be able to touch the hard palate in a partially opened mouth for adequate function. The sensory capacity of the tongue includes proprioception, pain, and taste. Intact sensation facilitates mastication, bolus manipulation, and positioning. The *hard palate* is the counterpart to the tongue for both speech and bolus preparation and transit in the oral phase of deglutition. The *buccal mucosa* lines the cheek and is important for mastication and deglutition. During reconstruction, it should be mobile enough to expand and allow for mastication, yet thin enough to avoid restriction of dental closure. The *base of tongue*, although technically part of the oropharynx, will be considered here as it is often involved with oral cavity defects. It participates in taste, deglutition and speech. The final push of the food bolus requires that the base of tongue occlude the oropharynx. Also, certain consonants require that the base of the tongue touch the hard palate.

Patient Factors

Patients should be evaluated on an individual basis, and a number of factors considered in determining the best reconstructive option. These include: the amount and type of tissue required, need for innervation, anticipated functional gain, anticipated donor morbidity, success rate, patient positioning, donor-site location, operative time, and potential dental rehabilitation. Patient factors including general medical status, prognosis, and the patient's wishes and expectations must also be considered. Patients should be thoroughly counseled in the preoperative period regardin all options for reconstruction. The experienced reconstructive surgeon should have a plan in mind as to which surgical procedures will likely be used. However, multiple options should be available when the final defect is analyzed, and some adaptability is required.

There are a number of patient factors to consider when planning reconstruction of oral cavity defects. A variety of medical problems can influence the success rate of reconstruction and overall wound healing. These include diabetes, hypercholesterolemia, atherosclerosis, and previous radiation therapy. Therefore, a complete medical history should be obtained preoperatively. Morbidity and mortality increase with the duration of anesthesia. This is particularly true in the treatment of head and neck cancer where surgeries run for extended periods of time. Free flap reconstruction can significantly increase the operating time for these surgeries, especially if a two-team approach is not possible. The patient's ability to withstand aspiration (when considering total glossectomy reconstruction) is also an important consideration. Other patient factors, such as smoking, obesity, existing coagulopathies, and hepatic disease should also be considered as they may limit reconstruction options. Again, the patient's expectations and motivation may be the most important factors to consider before choosing a particular reconstructive option.

Reconstruction of the Floor of Mouth

The floor of mouth requires soft and mobile tissue. It must be separated from, and allow for, free mobility of the oral tongue. It is important to avoid scar contracture as this may tether the tongue. Healing by secondary intention is generally not a good option. Bulk should be avoided anteriorly, as excessive bulk in this area may cause glossoptosis and/or obliteration of

the lower lip sulcus with resultant oral incontinence. There are many options for reconstructing the floor of mouth, and the tissue used will depend on the size and extent of the defect.

Smaller defects may be resurfaced with a full thickness or, more commonly, split thickness skin graft (STSG). STSGs are harvested from the lateral thigh at 0.017 inch thickness. This preserves the epithelium necessary for a water-tight closure without including the skin appendages. The graft is sutured into the oral cavity with absorbable suture and is stabilized with a bolster and/or quilting suture techniques. The STSG will survive over muscle and cancellous bone via imbibition and neovascularization. The advantage of skin grafting defects are decreased hospital stay, decreased operating time, decreased time to starting oral diets and decreased complication rates. Lateral floor of mouth and retromolar trigone defects can also be reconstructed using STSG's. Defects involving a large portion of the mylohyoid often require more tissue in this area such as a local, regional or distant cutaneous flap.

The nasolabial flap is a reliable flap that can be used for anterior floor of mouth defects. The advantage of this flap is its relative technical ease and great reliability. It is based on the angular artery and is best used in older patients with lax skin. The disadvantage of this flap is that it requires two stages and creates a temporary orocutaneous fistula. Bite blocks must also be placed to protect the flaps from damage.

Regional flaps useful for anterior floor of the mouth reconstruction are the forehead flap, submental artery island flap, facial artery musculomucosal flap (FAMM) and deltopectoral flap. The forehead flap is based on the superficial temporal artery and is reliable two-thirds the way across the forehead. The flap is tunneled inferiorly into the cheek below the zygoma and gains access to the oral cavity through a temporary superiorly-based orocutaneous fistula. The disadvantages of this flap are the obvious donor site defect (usually closed with a skin graft) and the need for a second stage to divide and inset the flap. Currently, this flap is rarely used for this defect. The submental artery island flap skin provides thin, supple cervical skin for anterior floor of mouth defects. It is based on the submental branch of the facial artery. The problems with this flap are its poor reliability if the facial artery is sacrificed during neck dissection or in previously irradiated necks. The FAMM flap is based on a branch of the facial artery and contains mucosa, buccinator muscle, and buccal fat. It can be based inferiorly to reconstruct the floor of mouth. Up to 2 x 8 cm flaps can be harvested without injury to the facial nerve. The deltopectoral flap is primarily of historical significance, as it is not commonly used for this type of reconstruction today. It is an axial flap based primarily on the first four perforators of the internal mammary artery, although fewer perforators have been used, especially if one or two are dominant arteries. The deltoid portion of the flap, which is the most useful for floor of mouth defects, is a random extension of the flap. This entails unacceptable risk for flap failure, so a preliminary delay procedure is necessary. Partial flap loss, despite the delay procedure is not uncommon. Another problem with the flap is the creation of a dependent, temporary orocutaneous fistula.

Free-tissue transfer is also capable of covering these defects. Fasciocutaneous free flaps are particularly useful due to the thin nature and pliability of these flaps. The radial forearm flap is a well-vascularized and pliable flap that has a low incidence of failure when transferred to this area. The thin nature of the flap provides for tongue mobility and allows for free movement of

food during oral deglutition. The radial forearm flap is based on the radial artery. Outflow from the flap is via the two venae comitantes accompanying the artery, the basilic vein, and the cephalic vein. The dependable blood supply and long vascular pedicle are particularly advantageous, especially in previously irradiated patients. Another potential advantage of this flap is its potential to become a sensate flap through anastomosis of the posterior cutaneous nerve to the lingual nerve. Reportedly, patients have demonstrated light/deep touch and hot/cold discrimination with sensate radial forearm flaps. The disadvantage of this flap is donor site morbidity (need for STSG closure, potential decreased forearem function, and potential loss of thumb and index finger).

Reconstruction of the Anterior Tongue

The tongue is one of the most difficult structures of the body to reconstruct. Restoration of the mobile tongue to its preoperative state is currently impossible due to the complex intrinsic musculature. Thankfully, due to the redundancy of this structure, a near-hemiglossectomy can be performed using primary closure without significantly altering the tongue's functional capacity. If primary closure cannot be obtained, a skin graft can be applied with satisfactory results. Larger defects or composite defects involving a portion of the floor of mouth will require more bulk. A fasciocutaneous free flap, such as the radial forearm free flap, is ideal for such composite defects, as the thin flap allows tongue mobility and creation of a glossomandibular sulcus simultaneously.

With defects involving some of the posterior tongue, more bulk is needed. The lateral arm free flap is a good option for these select defects. This flap is based on the posterior radial collateral artery and paired venae comitantes. A skin paddle up to 12 x 18 cm can be harvested, although limiting the paddle to 6 x 8 cm allows for primary closure of the defect. Harvesting the posterior cutaneous nerve with anastomosis to the lingual nerve allows for a potentially sensate flap. This flap has a thick proximal paddle and thinner distal paddle, which allows for extra bulk for more posterior tongue defects. The thinner portion of the paddle can be used for the floor of mouth aspects of the defect. The disadvantages of the flap are donor site appearance, hair growth at the recipient site, elbow pain and lateral forearm numbness.

Reconstruction of the Buccal Cavity

Small defects of the buccal cavity can be excised and closed primarily. More extensive superficial defects of the buccal mucosa can be repaired with quilted skin or mucosal grafts. The temporoparietal fascial flap based on the superficial temporal artery can also be used. This is a thin, pliable flap with a very reliable blood supply, and skin grafts will take over the flap to provide the intraoral lining. The flap is harvested and tunneled under the zygomatic arch and delivered into the oral cavity. Larger full-thickness defects must be replaced with regional, distant, or free flaps.

Regional flaps were discussed previously. The distant flaps commonly used are the pectoralis major and latissimus musculocutaneous flaps. The undersurface of the muscle will support a skin graft for intraoral lining. This will reduce the bulk associated with harvesting two skin paddles (latissimus) or de-epithelializing a portion of the flap and folding it (PMMF). The

PMMF is based on the thoracoacromial artery, and the latissimus flap is based on the thoracodorsal artery.

Other options include fasciocutaneous free flap reconstruction, such as the lateral arm or radial forearm flaps.

Mandibular Reconstruction

A variety of reconstructive methods have been suggested for mandibulectomy defects. The goal of mandibular reconstruction is to reconstitute the mandibular arch and allow for dental rehabilitation. Anterior defects result in the worst functional defects with the so-called "Andy Gump" deformity. Lateral defects pose less of a functional problem, so more options are available.

The preferred method for reconstructing anterior mandibular defects is through the use of osseocutaneous free flaps (with the fibula free flap being the most popular). The major blood supply is through the peroneal vessels. The artery supplies nutrients to the periosteum in a segmental fashion allowing for multiple osteotomies, which are required for bone shaping with anterior defects. A large soft tissue paddle based on septal and intramuscular perforators can be harvested to reconstruct intra-oral structures. The larger skin paddle is more reliable and usually survives 90% of the time. Up to 25 cm of bone may be harvested: enough to reconstruct entire mandible defects. The lateral cutaneous nerve of the calf supplies the skin paddle and can be anastomosed to the lingual or inferior alveolar nerve to provide a sensate flap. Osteointegrated implants can be placde in the bone graft. There are some situations in which other osseomyocutaneous flaps are better than the fibula. One is a mandible defect with both massive internal and external soft-tissue components. Another situation is the case of a retromolar trigone defect that extends into the oropharynx, soft palate and base of the tongue. Again, the soft tissue defect is more extensive with a limited bony defect involving the mandible angle and/or ramus. The more important goal with these defects is to provide adequate soft tissue coverage.

For lateral mandible defects, there are a number of reconstructive options. One is to provide soft tissue coverage without reconstruction of the bony defect. Lateral loss of the mandible creates much less disability for the patient compared to an anterior defect. Letting the mandible "swing" is an adequate option for select patients. There may be some lateral deviation with extreme opening, but with appropriate postoperative isometric exercise, mandibular drift is usually not a problem. Alternatively, bridging the defect with a low profile reconstruction plate and providing soft tissue lining over the plate with a regional, pedicled, or free flap is an attractive option in patients with advanced disease, who do not require dental restoration. Plate exposure is uncommon (5%) with lateral and posterior defects. However, with anterior defects, a plate exposure rate of up to 20% can be problematic.

The iliac crest free flap including the internal oblique musculature is a vascularized flap well suited for lateral mandible defect reconstruction. Its gentle curve parallels that of the mandible angle, and the ample mass and reliable vasculature to the bone permits contouring osteotomies. The corticocancellous nature of the graft is also beneficial in promoting rapid

healing, strength, and use of osseointegrated dental implants. This flap is based on the deep circumflex iliac artery (DCIA) with its perforators supplying the skin overlying the iliac crest and an ascending branch supplying the internal oblique muscle flap. The disadvantages to this flap are the technical difficulty of the harvest, significant donor site deformity/asymmetry, possible abdominal weakness and hernia (infrequent), frequent postoperative hematoma and lateral thigh pain and anesthesia. A modification of the flap harvesting a split inner cortex reduces or eradicates many of these problems and provides a more precise match to the native mandible.

The scapular free flap based on the circumflex scapular artery and vein is a suitable free flap option for very complex defects involving the mandible and oral cavity. It can be harvested to provide enough soft tissue to reconstruct a total glossectomy defect if necessary. Up to 14 cm of bone can be removed from the lateral aspect of the scapula, and this bone is generally thick enough to allow osseointegrated implants for dental reconstruction. The long pedicle, when traced back to the axillary artery, allows the fashioning of a variety of fasciocutaneous paddles for reconstructing extensive soft tissue defects. The fasciocutaneous or musculocutaneous flaps, which can be harvested independent of bone or as a composite graft, include: scapular (transverse branch of circumflex), parascapular (descending branch of circumflex), latissimus dorsi and serratus anterior (musculocutaneous independent flaps off the thoracodorsal). There are no distinct sensory nerves available to the variety of paddles in this system. However, the advantage of these flaps include a variety of skin paddle options, relative maneuverability of the separate bone, skin, and muscle components to one another and the overall success rate of bone (94%) and skin paddles when bone survives (near 100%). The drawbacks to this flap are the thin quality of bone and patient positioning, which prevents a two-team approach, increasing operative time substantially. The lateral decubitus positioning has also been associated with morbidity to the brachial plexus. Injuring to the glenoid fossa has also been reported. Harvesting of bone necessitates detachment of the teres major and minor muscles, which may result in shoulder weakness and decreased range of motion. Morbidity is markedly reduced when intense postoperative physical therapy is initiated early.

Special Considerations:

Total Glossectomy Defects

Total glossectomy defects require bulk during reconstruction. The goal here is to direct secretions laterally towards the oropharynx and provide contact of the neo-tongue with the palate to assist in deglutition. It is therefore more desirable to reconstruct this defect with a flap that will not atrophy over time. Vascularized fat and fasciocutaneous flaps are ideal choices for this reason. Providing a sensate flap may also be beneficial for bolus control. A palatal drop prosthesis can be used if additional closure of the neotongue with the palate is necessary. This decreases the size of the oral resonating cavity, which improves deglutition and speech quality.

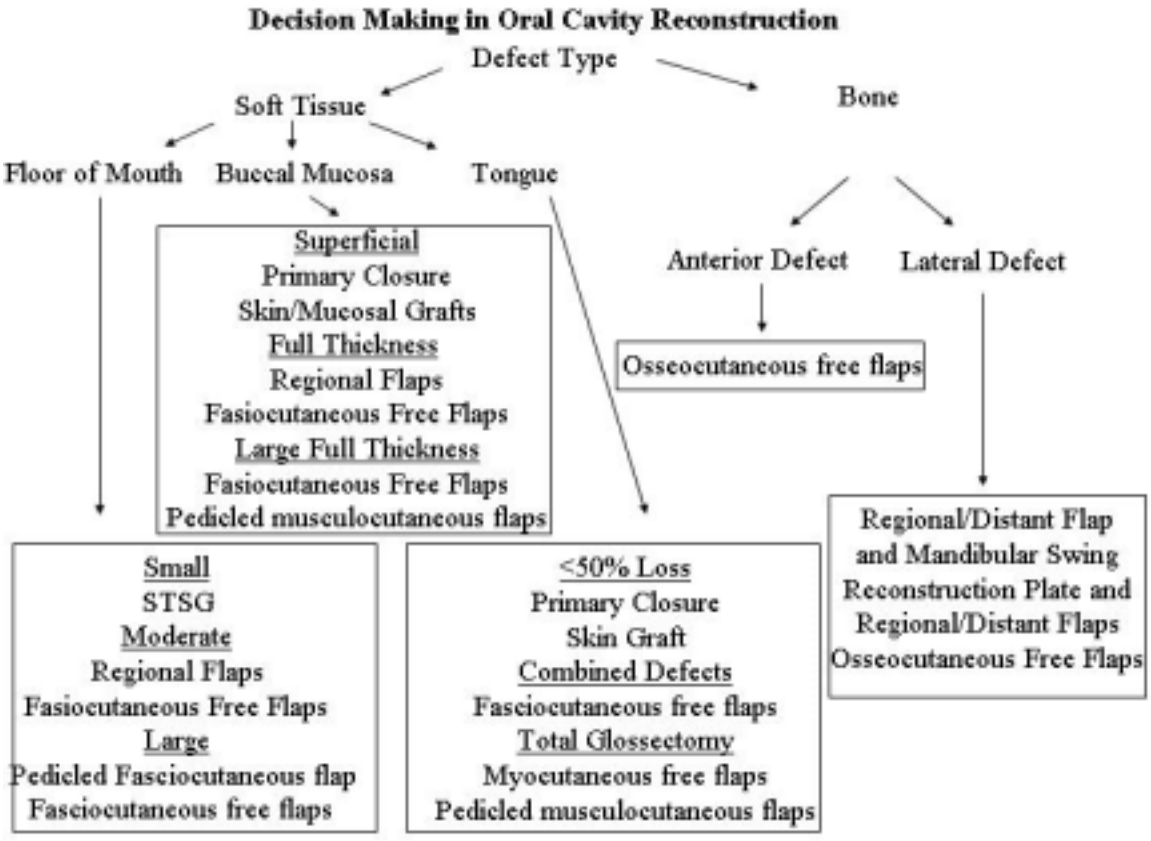
The rectus abdominis and latissimus dorsi myocutaneous free flaps are the most commonly used free flaps for total glossectomy reconstruction, although other fasciocutaneous free flaps are also used. The rectus abdominis is based on the inferior and superior epigastric arteries. The flap is harvested with the patient in the supine position and allows for a 2-team

approach. Motor nerves (intercostal) in this flap can be reanastomosed to the hypoglossal nerve to provide lasting bulk to the flap, but no movement of the neo-tongue. Over time, the rectus flap provides more bulk than other myocutaneous flaps. An innervated latissimus dorsi flap for reconstruction of partial and total glossectomy defects has also been described. This requires suturing the hypoglossal nerve stump to the thoracodorsal nerve. The pectoralis major and latissimus dorsi are the two most popular pedicled flaps for total glossectomy reconstruction.

Total Glossectomy with Laryngeal Preservation

Total glossectomy with laryngeal preservation can be performed safely in a select group of patients. These patients must be in good health and without significant cardiac and pulmonary disease in order to tolerate aspiration. Disease cannot involve the valleculae or preepiglottic space, which would require laryngectomy. Maintaining an intact superior laryngeal nerve is essential if laryngeal preservation is attempted. Useful speech can be attained at least 50% of the time. Laryngeal suspension lessens postoperative aspiration by moving the larynx to a more anterior-superior position. It is important to avoid compression of the flap or kinking of the vascular pedicle during suspension.

Decision Making in Oral Cavity Reconstruction



Conclusion

A multitude of reconstructive options are possible for patients with intraoral defects. The technique chosen largely depends on the extent and functional characteristics of the tissue involved. The overall health status, expectations, and overall motivation of the patient will factor heavily in choosing the type of reconstruction. It is imperative that the surgeon counsel the patient preoperatively concerning risks of surgery and postoperative expectations. In the ideal patient, tissue that most closely resembles the preoperative functional characteristics of the deficient tissue should be chosen. A high degree of success is usually possible with proper patient selection and careful surgical technique.

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