Head and Neck Cancer - Reconstruction

- Author: Samuel J Lin, MD; Chief Editor: Jorge I de la Torre, MD, FACS more...

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Overview

History

Head and neck tumors can lead to devastating cosmetic and functional deficits with resultant psychological, physical, and nutritional detriment. Despite recent advances in medicine, the overall survival for patients with head and neck has remained static for the past 35 years.[1, 2] This survival rate has led to the establishment of the principles of tumor excision with maximum tissue sparing (eg, Mohs technique for skin cancer removal) and newer endoscopic laser-assisted techniques for aerodigestive tract cancers aiming at decreasing surgical morbidity without affecting the overall survival.

As the role of adjuvant radiation and chemotherapy increases, plastic and reconstructive surgeons will continue to manage defects in irradiated fields, which may decrease the chance of local flap availability and increase the demand for distant pedicled and free flaps.

Deformities of the head and neck region can have devastating effects on appearance and function of the patient and are among the most disabling and socially isolating defects with significant impact on patient's quality of life. Reconstruction of such defects continues to be an extremely demanding challenge for plastic surgeons who aim to restore form and function with minimal surgical morbidity.

The desire to alleviate these problems led to the development of plastic surgery as early as 3000 BC.

- In 3000 BC, the Edwin Smith Surgical Papyrus, from ancient Egypt, described the first surgical management of facial trauma, including the treatment of mandibular and nasal fractures. Treatments at that time were simple including reduction of the nasal fracture followed by nasal cleaning, packing, and splinting with linen.[3]
- In the sixth century BC, Sushruta, from northern India, described the first operative procedures for nasal reconstruction by transferring skin from the forehead and the cheek.[4]
- In the 1950s, defects were repaired using a forehead flap or temporal flap combined with split-thickness skin graft, but this lead to a scarred forehead or temporal contour deformity.[5]
- In 1959, Seidenberg et al described the first revascularized flaps to the head and neck, but they only gained popularity when they were re-introduced by Daniel and Taylor in 1973.[6]

- In 1965, Bakamjian first described the deltopectoral flap.[7]
- In 1973, Daniel and Taylor reported the first free flap, the transplant of an autologous skin flap to the lower extremity using the operating microscope.[6]
- In 1976, Panje and Harashina simultaneously described the use of free flaps to reconstruct defects of the oral cavity.[8, 9]
- In 1979, Ariyan described the pedicled pectoralis major myocutaneous flap.[10]
- In the late 1980s and early 1990s, the use of osteocutaneous free flaps to reconstruct mandibular defects was advanced.

Frequency

In the United States, 2008 estimates are 35,310 new cases of cancer of the oral cavity and pharynx and 12,250 new cases of cancer of the larynx.[11]

General Concepts of Reconstruction

Successful reconstruction requires a team approach, which includes a medical oncologist, ablative surgeon, and reconstructive surgeon, for careful preoperative assessment and development of a treatment plan. Important considerations include tumor stage and prognosis; patient age, sex, body habitus, and functional status; available reconstructive donor sites; and the psychosocial make-up of the patient.

The reconstruction ladder consists of the following steps starting from the simplest to the most complex option:

1. Healing by secondary intention
2. Primary closure
3. Skin grafting (split or full thickness)
4. Composite grafts
5. Local flaps
6. Regional pedicled flaps
7. Free tissue transfer

Alloplastic materials (synthetic compounds), such as porous polyethylene (Medpor), polytetrafluoroethylene (Gore-Tex), silicone, and titanium, are occasionally used for structural or bony reconstruction.[12]

As a general rule, when planning an individual patient's reconstruction, attempt the least complex and safest option from the reconstructive ladder first, while maintaining form and function. The plastic surgeon should be comfortable with the full armamentarium of reconstructive techniques, and should be able to decide which technique is the best for each particular patient and defect.

The remainder of this article covers the reconstruction of specific anatomical entities of the head and neck.

Reconstruction of Lip Defects

The lower lip is the site of more than 90% of cancers of the lips, as it receives more ultraviolet exposure than the upper lip.

Anatomy

The lips are formed of 3 layers: skin, muscle (orbicularis oris), and mucosa. The vermilion (“red lip”), which is formed of modified mucosa, is the myocutaneous junction; it includes the “white line” where the skin meets the vermilion. Alignment of this zone is the initial step in lip skin closure, as minute defects are easily noticeable.

The superior and inferior labial arteries (branches of the facial artery) provide the blood supply to the lips. They course deep to the mucosal surface of the lip.

The motor nerve supply of the lips is from the facial nerve, through the buccal and mandibular branches. The sensory enervation is from the trigeminal nerve, through the infraorbital branch (upper lip) and mental branch (lower

lip). All these nerves are deep to the muscle except the mandibular nerve which courses superficial to innervate the mentalis muscle; the buccinator muscle and the depressor angularis are innervated on the superficial surface.

Reconstruction of the Lower Lip

Lower lip reconstruction depends on the defect size.

- Defects smaller than one third of the lip can be repaired with a V or W resection, followed by primary 3-layer closure. To avoid crossing the mentolabial groove, select V resection for smaller defects and W for larger defects.
- Defects between one third and two thirds of the lip can be repaired with the staircase technique, which entails progressive horizontal distances that involve half of the defect width.
- Defects that cover more than 60% of the lip usually require rotational flaps to be closed (eg, Abbe, Estlander, Bernard, Gillies, McHugh, Karapandzic).

Abbe (Sabattini) transoral cross-lip flap

- Described by Sabattini in 1836 and by Abbe in 1968, this flap involves the transfer of full-thickness V-, W-, or rectangular-shaped lip tissue from one lip to the other.[13, 14]
- To keep the size of the 2 lips equal, the width of the flap should be half of the defect and the height of the flap should equal that of the defect.
- The flap blood supply is based on the labial artery and small veins that parallel the artery.
- The flap is pivoted approximately 180° on its pedicle and is sutured in the defect.
- Three weeks later, the flap is divided, and the donor site is closed primary.

Estlander flap

- This is a cross-lip flap that involves rotating tissues from the upper lip, with point of rotation at the commissure, to correct defects involving the oral commissure.
- It is based on the labial artery.
- It requires commissuroplasty at 3 months.
- The flap length is 1-2 mm longer than defect size and is half the defect width.
- The incision is placed in the ipsilateral melolabial crease.
- This flap maintains motor and sensory competence of lip.

Karapandzic flap

- The Karapandzic flap is described for central lower lip defects. A complete lip is formed by rotating the upper lip and perioral tissue by bilateral advancement-rotation flaps.
- Semicircular incisions can be created from the defect, but the nasolabial folds are a better location at which to start the incisions.[15]
- Partial-thickness incisions should be made through the skin and muscle. Muscle fibers should be mobilized by blunt dissection, and neurovascular structures should be identified and preserved bilaterally. The incision is carried inferior into the mental crease at the midline. Advancement results in closure of the lip defect. Burrows triangles are removed at the lateral portion of the incision.

Gillies fan flap

- This is a rotational advancement flap that advances the remaining lip segment with a portion of the other ipsilateral lip to close a lip defect.
- It uses bigger tissues and results in less microstomia.

Bernard-Burow flap

- This flap uses cheek tissue to replace defects.
- Horizontal incisions are carried through the skin from the commissure to the melolabial fold. Subcutaneous tissue and a skin triangle are created adjacent to the melolabial fold.
- Intraoral mucosal advancement flaps are created from labium.
- Flaps are advanced into the lower lip defect with mucosal advancement to create new lower lip vermilion.

- Burrows triangle tissue is excised and the remaining defect closed.
- This technique may reconstruct a total lip defect.

Combined flaps

- Combined multistage flaps can be used for larger defects.
- The bilobed and Karapandzic flaps may be used to reconstruct an 80% defect of the lower lip.[15]
- Two Abbe flaps can be used in combination.
- Extended Karapandzic flaps followed by cross-lip flaps can restore symmetry and balance between the lips.[16]

Free flap for total lip reconstruction

- The lower lip and chin can be reconstructed with a composite radial forearm-palmaris longus free flap.[17]

Table. Flaps for Lower Lip Reconstruction (Open Table in a new window)

Flap	Use	Advantages	Disadvantages	Potential Complications
Abbe	1/2-1/3 lip defects	Return of sensory/motor innervation	Cross-lip flap	Vascular compromise
			Second surgery	Vermillion notching
		Full-thickness lip tissue transfer		
			Relative microstomia	Lip asymmetry
		Restoration of orbicularis oris	Temporary denervation	Scarring extension beyond sublabial crease
		No commissure violation	Trap-door deformity as scar appears thickened	
Estlander	1/2-1/3 lip defects involving oral commissure	Maintain motor/sensory competence of lip	Requires commissuroplasty	Commissure violation
		One stage		
		Scar can be hidden in skin crease		
		No mouth closure		

Karapandzic	Central lower lip defects up to 3/4 of lip	Preservation of neurovascular supply	Microstomia Difficult to introduce full dentures Inversion of vermillion Flattened mentolabial junction	Dysesthesia/anesthesia of lip
Gillies fan	Defects up to 3/4 of lip	Less microstomia	Full sensation may not return	Oral incompetence may result
Bernard-Burow	Up to total lip defect	Aesthetic result	Not for defects below labiomental crease Adynamic reconstruction	Postoperative drooling

Reconstruction of the Upper Lip

- For defects that cover up to 50% of the upper lip, primary closure as described for the lower lip is performed.
- For defects that involve between one third and two thirds of the upper lip, the Abbe and Estlander flaps are preferred.
- For defects that involve at least two thirds of the upper lip, use a modified Burow technique, which uses perialar crescentic excisions and laterally based advancement flaps.
- Reverse Karapandzic flap can be performed.

Reconstruction of Floor of Mouth and Alveolar Ridge Tumors

History

Cancers of the floor of mouth (FOM) predominate in men in their fifth and sixth decades of life. Multifocal carcinomas are more common in patients with tumors of the floor of the mouth. Most tumors are composed of a squamous cell histologic type. The most common gross morphology is a superficial exophytic tumor of well or moderately well differentiated grade. Ulceration follows continued tumor growth with subsequent extension into adjacent soft tissue structures such as the oral tongue, submandibular space, and alveolar ridge. Bony involvement is heralded by tumor fixation, and restricted tongue mobility signifies invasion of intrinsic tongue musculature.

Squamous cell carcinoma originating in the alveolar ridge is less common when compared to other sites in the oral

cavity. Women are more commonly affected than men, and it occurs during the sixth decade of life. Of gingival cancers, 70% occur on the lower gum in the posterior third of the molar area. Most of these tumors spread to adjacent areas of the oral cavity and frequently are associated with bone destruction due to the tight mucosal adherence of the gingiva to the mandibular periosteum.

Anatomy

The floor of the mouth consists of the semilunar space of the mylohyoid and hyoglossus muscles extending from the inner aspect of the lower alveolar ridge to the undersurface of the tongue. This region extends to the anterior tonsillar pillar posteriorly. The ductal openings of the paired sublingual and submandibular glands are situated in the mucosal floor, separated by the midline frenulum of the tongue.

The lower alveolar ridge consists of the alveolar process of the mandible and its lining mucosa. The area extends from the line of insertion of the mucosa in the buccal gutter to the line of the free edge of the FOM mucosa. The posterior extent is defined by the ascending ramus of the mandible. The upper alveolar ridge extends from the upper gingival buccal gutter to the junction of the hard palate. It includes the alveolar ridge of the maxilla and its lingual mucosa. The posterior extent is defined by the superior end of the pterygopalatine arch.

Reconstruction of small intraoral defects

- Primary closure can be done in buccal region and tongue, but tethering can lead to poor tongue mobility, interfering with speech and deglutition.[18]
- Grafting has the disadvantage of scar contracture.
- Closure by secondary intention can be used in the alveolar arches or hard palate defects, where scar contracture is not significant.

Reconstruction of large intraoral defects

- Free flaps are the ideal mode of reconstruction for large defects of the upper aerodigestive tract.
- The radial forearm and anterolateral thigh free flaps are the major workhorses. They are thin and pliable, and they can be folded or tubed to compensate for palatal and pharyngeal defects.[19, 20]
- The radial forearm flap is considerably thinner than the anterolateral thigh flap. The anterolateral thigh flap donor site can usually be closed primarily with minimal morbidity, yet it is more technically demanding to elevate.[21]

Reconstruction of large advanced-stage defects

- Late-stage cancers of the FOM include tumors that invade the mandible, intrinsic musculature of the tongue, and anterior tonsillar fossa. Management of these advanced tumors requires wide local resection that may include cortical or segmental mandibulectomy, en bloc FOM musculature resection, and partial or hemiglossectomy.
- Tumors with extensive anterior growth from the FOM may invade the lip or skin of the lower face.
- Total or partial loss of the mandible incurs serious functional, aesthetic, and psychological morbidity for patients. Prior to the development of advanced reconstruction options for mandibular defects, patients were left with terrible cosmetic deformities and poor function, as observed in the so-called "Andy Gump" deformity, with anterior mandibular arch defects. While en bloc resection of advanced oral cavity tumors can be reconstructed with regional tissue transfer, such as the pectoralis major musculocutaneous flap or free flaps, bony defects are best managed with an osteocutaneous free flap or in combination with regional tissue transfer.

Mandibular Reconstruction

Fibula flap

- The fibula flap consists of the fibula bone and associated soft tissue paddle. Its blood supply comes from the endosteal and periosteal branches of the peroneal artery.[22]
- Advantages
    - As much as 25 cm of fibula bone can be harvested in an adult.
    - Extensive periosteal vascular support allows multiple osteotomies for aesthetic and functional

reconstruction of the mandible.
    - This flap can reconstruct angle-to-angle mandibular defects.
    - The bicortical bone of the fibula accepts plates and screws for fixation and osseointegrated dental implants.
    - This flap provides potential sensory reinnervation via the lateral sural nerve.
    - This flap allows simultaneous flap harvest and single-stage reconstruction with a two-team approach.
- Disadvantages
    - The soft tissue component of the flap is limited.
    - The poor arc of rotation of the skin island relative to the bone and its unpredictable vascularity are factors in this limitation.
    - Patients with severe peripheral vascular disease may not be candidates for flap harvest if the lower limb vasculature is involved.
- Potential donor site morbidity
    - Pain (60%)
    - Dysesthesia (50%)
    - Feeling of ankle instability (30%)
    - Inability to run (20%)[23]
    - Fibular flap failure (In the event of fibular flap failure, the necrotic soft tissue can be excised, leaving the bone component in place until the end of radiotherapy; then, a new fibula flap procedure can be performed. This avoids delay in radiotherapy and retraction at the site of bone flap.[24]

Iliac crest flap

- The iliac crest flap is a source of large bone volume for mandible reconstruction after obliterative head and neck surgery. Its blood supply comes from the deep circumflex iliac artery.
- Advantages
    - Thick bicortical bone in the iliac crest can accept osseointegrated implants.
    - After harvest, the scar site is hidden.
    - The distance of the harvest site from the head allows simultaneous harvest and single-stage reconstruction.
    - This flap provides a large cutaneous island for composite defects.
    - A total of 14-16 cm of iliac crest can be harvested, and osteotomies that conform to most mandible defects can be made.
    - This flap can supply additional thin, pliable tissue for oral cavity and pharyngeal mucosal defects.
    - The internal oblique muscle may be incorporated into the flap with dissection of the ascending branch of the deep circumflex iliac artery, which supplies this muscle.
- Disadvantages
    - Skin island harvest requires a large surface area to incorporate sufficient musculocutaneous perforators.
    - The bulk of the skin island and subcutaneous tissue limits the ability to reconstruct the contour of oral cavity defects, especially in patients who are obese.
    - Harvest of the iliac crest flap produces donor site pain.
    - The risk of retroperitoneal hematoma is a disadvantage.
    - The risk of abdominal wall herniation is a disadvantage.

Scapular flap

The blood supply of this flap is the subscapular artery.

- Advantages
    - This flap offers bone from the scapula and 2 thin skin paddles based on the scapular and parascapular flaps, respectively. Harvesting the tissue at the level of the circumflex scapular artery supports both skin paddles and the bone.
    - This permits reconstruction of modest mandibular resections and provides intraoral lining and soft tissue coverage for the cheek and neck.
- Disadvantages
    - When this flap is used, the patient needs to be repositioned intraoperatively.
    - The skin paddle and the bone component have different blood supplies, which come together to form

the scapular circumflex artery. Therefore, the vascularization of the skin paddle and the bone component can sometimes be completely dissociated.[24]

Soft Tissue Reconstruction of Oral Cavity

Regional pedicled flaps and free flaps are used to reconstruct oral cavity defects caused by tumor ablation.

Regional pedicled flaps are based on axial pattern blood supply. Pedicle location and length define the limits of regional flaps in head and neck reconstruction. Primarily, branches of the subclavian or axillary arteries supply the regional flaps used in reconstruction of the head and neck. The right subclavian artery arises from the right innominate artery while the left subclavian artery arises directly from the aortic arch. The axillary artery begins at the lateral border of the first rib as a continuation of the subclavian artery. The axillary artery is divided into 3 parts by its relation to the pectoralis minor muscle. The axillary artery has 3 main branches: the superior thoracic artery, thoracoacromial trunk, and subscapular trunk. The 2 primary branches of the subclavian artery are the thyrocervical and costocervical trunks.

Regional flaps can be classified as fasciocutaneous (eg, deltopectoral flap) or as myocutaneous (eg, pectoralis major, latissimus dorsi, trapezius flaps). Selection of a certain regional flap depends on the size and location of the defect and the limitations of the regional flap choices. The pectoralis major myocutaneous pedicled flap (PMMPF) is described below as it is considered the workhorse of pedicled flaps for head and neck reconstruction.[25]

Regional flaps

- Pectoralis major flap
  - The blood supply of the pectoralis major flap is the pectoral branches of the thoracoacromial artery.
  - To spare skin for a later deltopectoral flap option, extend the lateral skin incision toward the anterior axillary fold.
  - The motor nerve supply should be identified and cut to prevent muscle contraction.
  - Advantages
    - This flap offers one-stage reconstruction.
    - The patient's position need not be changed intraoperatively.
    - This flap provides a large cutaneous island that can be used for defects involving 2 epithelial surfaces.
    - The muscular part covers neck structures protecting the carotid artery, especially in patients who have undergone radiation therapy.
  - Disadvantages
    - The flap can conceal recurrences, making follow-up in the neck area more complicated.
    - In women, the flap might include breast tissue, which may lead to breast asymmetry.
    - In males, hirsute chest skin is placed intraorally.
    - This flap causes loss of pectoralis muscle function in arm adduction and/or rotation.
    - In patients who are overweight, the flap is bulky, which leads to postoperative contour deformities.[26]
- Submental island flap
  - The blood supply of the submental island flap is the submental artery.
  - This flap can be used for the reconstruction of the following structures:
    - Lip
    - Tongue
    - Buccal mucosa
    - Floor of the mouth
    - Lower gingiva
    - Oropharynx
    - The palate
    - Facial skin
  - Care should be taken during elevation of this flap in identifying and preserving the marginal mandibular branch of the facial nerve.[27]
  - Limitations of the regional pedicled flap, together with the advancements in microvascular free tissue

transfer, has led to the broad application of free tissue transfer in head and neck reconstruction

Free flaps

The characteristics of an ideal free flap for head and neck reconstruction include the following:

- Pliable so as not to impair movement in head and neck
- Consistent, large and long pedicle
- Possibility of variable size and thickness
- Harvesting the flap can be consistent and can be done by reconstructive surgeon in the same time of tumor excision
- Minimal donor site morbidity

The 2 main choices of free flaps are the radial forearm free flap and the anterolateral thigh free flap. Perforator flaps are also described below.

- Radial forearm free flap
  - Since it was first described by Song et al in 1982, the radial forearm free flap has become a workhorse flap in head and neck reconstruction.[28]
  - Advantages
    - The radial forearm flap has most of the desired characteristics of the ideal free flap.
    - It provides a skin paddle that is thin, reliable, pliable, and predominantly hairless.
    - Its harvest is safe and consistent.[29]
  - Potential donor site complications
    - Donor site not hidden
    - Donor site closure consists of skin grafting
    - Partial skin graft loss
    - Tendon exposure
    - Fracture of the radius at bone harvest site
    - Sensory loss in distribution of the superficial radial nerve
    - Restricted forearm function
    - Vascular compromise of the hand (This is the most devastating complication related to harvest of the radial forearm free flap. This occurs when insufficient collateral circulation via the ulnar artery exists. Use of the preoperative Allen test, in which the distal perfusion of the hand is ensured while occlusion of the radial artery is performed, eliminates the risk for postoperative vascular insufficiency.)
  - Potential donor site complications have led some centers to shift toward the anterolateral thigh flap in recent years.[30]
- Perforator flaps
  - Perforator flaps are skin or subcutaneous tissue flaps based on the dissection of a perforating vessel.[31]
  - Advantages
    - Reducing muscle harvest minimizes donor site morbidity.
    - The long-term bulk of free tissue transfer is more predictable, as it avoids transfer of denervated muscles.
  - Disadvantages
    - The dissection of small perforating vessels may be tedious and challenging.
    - Variable position and size of the perforator vessels can be a disadvantage (Doppler ultrasonography is routinely used to locate the perforator arteries).
  - Contraindications
    - Small perforator size
    - Scarring at the donor site
- Anterolateral thigh free flaps
  - The anterolateral thigh flap is likely the most widely used perforator flap for head and neck reconstruction. It is based on the descending branch of the lateral circumflex femoral artery.
  - Advantages
    - This flap provides a long, large vascular pedicle.

        - This flap can provide a huge amount of skin, muscle, and fascia with little donor site morbidity.
        - It can be used as a sensate or a flow-through flap.[32]
        - The anterolateral thigh free flap can technically be combined with iliac bone.[33]
        - This flap can be harvested simultaneously during tumor excision.
    - Disadvantages and potential complications
        - Sometimes requiring second-stage thinning, the thigh flap can be thinned principally. This concept was proposed by Kimura under the operating microscope (microdissection).[34] This technique is accompanied by an unacceptably high rate of flap failure.[35]
        - Patients may experience fatigue and weakness when climbing and descending stairs.
        - Use of split-thickness skin graft (STSG) at the donor site may be complicated by decreased range of motion at the hip and knee joints as a result of adhesion between the skin graft and the underlying muscle.[36]
        - Hypesthesia, anesthesia, numbness, and deceased tolerance to cold may occur in the distribution of the medial branch of the lateral cutaneous nerve of the thigh that is usually sacrificed to protect the perforator.[37, 38]
- Repair of free flap failure
    - Second free flap
    - Regional pedicle flap
    - Conservative management with debridement; wound care followed by closure by secondary intention (This approach should not be used when flap failure resulted in fistula in the neck.)[39, 24]

Reconstruction of Tumors of the Oropharynx

Primary closure, skin grafts, local pedicled flaps, and microvascular free flaps are all in the reconstructive armamentarium for the pharyngeal defects. In the past, the goals of oral and oropharyngeal reconstruction were to close the defects and to avoid local postoperative complications. However, the goals of reconstruction are now to regain function (swallowing, speech, and breathing) and to improve the patient's quality of life.

Resection of the intrinsic and extrinsic musculature of the tongue affects speech and swallowing functions. Reconstruction should aim at restoring mucosal surface, muscle bulk, and movement and sensation, whenever possible.

Anatomy

The oropharynx is bounded by the following structures:

- Anteriorly - The oral cavity separated is from it by the anterior tonsillar pillar, consisting of the palatoglossus along with the soft palate and circumvallate papillae at the tongue base
- Inferiorly - The hypopharynx at the at the level of the hyoid bone
- Superiorly - The nasopharynx at the horizontal plane of the soft palate
- Posteriorly - The posterior pharyngeal wall

Reconstruction of soft palate defects

Defects of the soft plate result in velopharyngeal incompetency (ie, inability to seal the oropharyngeal and nasopharyngeal cavities in speech and deglutition). Primary closure of the smallest of soft palate defects can lead to rhinolalia aperta, leading to a noticeable change in voice resonance due to air escape behind an incompetent velum. Swallowing problems are most noticeable after ingesting liquids, with a resulting nasal regurgitation.

Following the surgical ablation of lateral soft palate and tonsillar fossa defects, the radial forearm free flap can be used for reconstruction. However, small defects can be effectively closed primarily or with split-thickness skin graft (STSG).

Extensive palatomaxillary defects that need repair after surgical ablation can be reconstructed with a prosthesis (though this provides suboptimal functional results) or with vascularized bone-containing free flaps (eg, fibula or

iliac crest internal oblique osteomusculocutaneous free flap).[40]

Reconstruction of base of tongue

Tongue base cancers account for approximately 40% of all oropharyngeal carcinomas and are associated with significant degrees of functional morbidity, as the tongue is among the areas most difficult to reconstruct.[41] This led to the historical rationale of initially treating most primary tumors of the base of tongue with combined chemotherapy and radiation therapy protocols. In recent years, surgical reconstructive techniques have continued to advance, improving functional outcome so that the consideration of surgery as the primary treatment is now being revised.[42]

Small defects of the base of the tongue can be repaired with primary closure. Large defects can be repaired with myocutaneous flaps, such as rectus or pectoralis major flaps, and with fasciocutaneous flaps, such as the radial forearm free flap.

Recent reports reveal the improvement of functional outcome with the use of the radial forearm flap.[41] Yagi et al described a new design for free flap reconstruction of tongue base consisting of 4 lobes on a single pedicle.[43] The first reconstructs the tongue, the second the tongue base, the third the oral floor, and the fourth the lateral wall. They reported excellent functional results in 23 patients.[43]

Reconstruction of posterior pharyngeal wall

Small defects can be closed primarily closure or with STSG. Larger defects usually require free flap reconstruction. In this case, the radial forearm or lateral arm flaps are preferred to thicker flaps.

Reconstruction of Pharyngoesophageal Defects

Hypopharyngeal carcinomas are associated with poor prognosis because of a combination of late diagnosis, aggressive tumor behavior with tendency for submucosal spread, skip lesions, and spread into the surrounding structures of the neck.

Advances in chemoradiation and altered fractionated radiotherapy protocols have enabled laryngeal preservation in many patients with marginal improvements in survival over conventional radiotherapy. Yet, surgical salvage after definitive radiation therapy is not rare. Other patients are not suitable candidates for chemoradiation and their carcinomas are best managed with primary surgery. However, following laryngopharyngectomy, the reconstructive surgeon is faced with a challenging condition. He or she should aim at adequate functional restoration regarding swallowing and voice, together with minimizing morbidity in such high-risk vulnerable patients.[44]

Anatomy

The hypopharynx extends from the level of the hyoid bone superiorly to the lower border of the cricoid inferiorly. It is a cone-shaped structure in continuity with the oropharynx above and the cervical esophagus below. The hypopharynx is divided into the following regions: paired pyriform sinuses, postcricoid, and posterior pharyngeal wall.

Pyriform sinus cancer is the most common. The sinuses extend from the pharyngoepiglottic folds superiorly to an apex inferiorly lying at the level of the glottis. Laterally, it is bounded by the overlying thyroid cartilage and thyrohyoid membrane. Medially, the pyriform sinus is closely related to the laryngeal structures. The posterior pharyngeal wall is separated from the vertebral bodies posteriorly by the prevertebral fascia and the retropharyngeal space. Tumors arising de novo here are rare.

Postcricoid cancer tends to spread superficially, extending into the cervical esophagus and pyriform sinuses. The postcricoid area extends inferiorly from the posterior surfaces of the arytenoids and the intervening mucosal fold to the inferior margin of the cricoid cartilage. The upper cervical esophagus originates at the lower border of the cricoid.

Reconstruction

Reconstruction of the pharynx and cervical esophagus after resection for tumor involvement is most commonly attained with the use of free tissue transfer. The main factor affecting choice of reconstruction is the extent of pharyngoesophageal defects.

- Partial defects can be reconstructed with the following flaps:
  - Pectoralis major flap
  - Anterolateral thigh flap
  - Cutaneous deltopectoral flap
- Circumferential defects can be reconstructed with the following flaps:
  - A tubed radial forearm or anterolateral thigh flap can be used.
  - The jejunal flap was the workhorse for pharyngeal reconstruction. However, recent concerns have arisen about bad voice quality and intermittent dysphagia due to uncoordinated peristalsis during deglutition. Also, this flap harvest requires laparotomy.
  - Preliminary reports reveal that gastro-omental flaps provide vascularized omentum that can be draped around the pharyngeal anastomoses.[45]
  - If the cervical esophagus is involved, gastric transposition is the best management.[44]

Cutaneous and Soft Tissue Defects

- Skin defects can be reconstructed using the reconstruction ladder mentioned above.
- Ideally, skin defects should be closed while maintaining the color, thickness, and texture of the skin.
- Small defects
  - Small defects can be repaired with primary closure.
  - Local tissue flaps (eg, bilobed, rhomboid, rotational) provide the best aesthetic and functional results.
  - Skin graft use is limited because of color mismatch, contour irregularity, and graft contracture.
- Moderate defects: Larger local flaps (eg, nasolabial, paramedian forehead, dorsonasal) can be used to repair moderate defects.
- Large defects
  - Free flaps: The radial forearm and anterolateral thigh flaps are good for this region, as they are thin and pliable and allow for contouring over the facial skeleton.[46, 47]
  - Distant pedicled flaps such as pectoralis major, latissimus dorsi, and trapezius may be used as salvages for free flap failures or in neck defects, but they are less than ideal for facial defects.

The Horizon

- Conservative surgical options, including the Mohs technique for skin cancer removal, newer endoscopic laser-assisted techniques for aerodigestive tract cancers, and endoscopic skull base tumor resection continue to pave the way toward more organ-sparing treatment plans. These conservative endoscopic techniques require new limited endoscopic reconstruction techniques.
- Transoral robotic surgery (TORS) for base of tongue neoplasms is a new emerging modality of surgery that may pave the road to more conservative surgeries. Reconstructive surgeons should be aware of the new technological and surgical advances.[48]
- Research is now progressing in the field of stem cell and osteosynthesis. The potential that this research can provide rapid de novo bone growth may eliminate the need for vascularized bone flaps.
- Gene therapy and immune system targeting are newer treatment modalities entering the battle against head and neck cancer. Through a combination of viral and nonviral vectors, immune stimulation, and monoclonal antibodies, researchers are working to attack cancer at the cellular and molecular levels. As this technology progresses, it will determine what role surgery, traditional chemotherapy, and radiation will play in the treatment options.[49, 50]

Conclusion

Head and neck reconstruction is an extremely demanding process that needs continues improvements and refinements. Patients' cases should be managed with a team approach, including oncologists, ablative surgeons,

and reconstructive surgeons. Despite the progress achieved in this field, frustration of head and neck reconstruction remains because of the inability to attain complete functional and cosmetic recovery with current techniques.

In recent years, free flaps have become the workhorse in head and neck reconstruction; most centers are reporting success results higher than 96%, with the possibility of free flap salvage for failures. A competent reconstructive surgeon should be familiar with the armamentarium available for reconstruction, understanding the advantages and limitation of each technique and knowing when and where to adopt each one.

Contributor Information and Disclosures

Author
Samuel J Lin, MD Attending Surgeon, Plastic Surgery, Division of Otolaryngology-Head and Neck Surgery, Beth Israel Deaconess Medical Center, Associate Staff Physician, Otolaryngology, Division of Head and Neck Surgery, Massachusetts Eye and Ear Infirmary, Harvard Medical School

Samuel J Lin, MD is a member of the following medical societies: American Academy of Otolaryngic Allergy, American Academy of Otolaryngology-Head and Neck Surgery, American College of Surgeons, American Medical Association, American Society for Reconstructive Microsurgery, American Society of Maxillofacial Surgeons, American Society of Plastic Surgeons, and Triological Society

Disclosure: Nothing to disclose.

Coauthor(s)
Amr Nabil Rabie, MD, MS International Research Fellow, Department of Plastic Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School; Lecturer, Department of Otolaryngology-Head and Neck Surgery, Ain Shams University, Egypt

Amr Nabil Rabie, MD, MS is a member of the following medical societies: Egyptian Otorhinolaryngological Society and European Academy of Facial Plastic Surgery

Disclosure: Nothing to disclose.

Specialty Editor Board
Lawrence Ketch, MD, FAAP, FACS Head, Program Director, Associate Professor, Department of Surgery, Division of Plastic Surgery, University of Colorado Health Sciences Center; Chief, Pediatric Plastic, The Children's Hospital of Denver

Lawrence Ketch, MD, FAAP, FACS is a member of the following medical societies: American Academy of Pediatrics, American Association for Hand Surgery, American Association of Plastic Surgeons, American Burn Association, American Cleft Palate/Craniofacial Association, American College of Surgeons, American Society for Surgery of the Hand, American Society of Maxillofacial Surgeons, American Society of Plastic Surgeons, Association for Academic Surgery, and Plastic Surgery Research Council

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Francisco Talavera, PharmD, PhD Adjunct Assistant Professor, University of Nebraska Medical Center College of Pharmacy; Editor-in-Chief, Medscape Drug Reference

Disclosure: Medscape Salary Employment

Jaime R Garza, MD, DDS, FACS Consulting Staff, Private Practice

Jaime R Garza, MD, DDS, FACS is a member of the following medical societies: Alpha Omega Alpha, American Academy of Otolaryngology-Head and Neck Surgery, American College of Surgeons, American Society for Aesthetic Plastic Surgery, American Society of Maxillofacial Surgeons, Texas Medical Association, and Texas Society of Plastic Surgeons

Disclosure: Nothing to disclose.

Nicolas (Nick) G Slenkovich, MD Director, Colorado Plastic Surgery Center

Nicolas (Nick) G Slenkovich, MD is a member of the following medical societies: American Academy of Otolaryngology-Head and Neck Surgery, American College of Surgeons, American Medical Association, American Society of Aesthetic Plastic Surgery, American Society of Plastic Surgeons, and Colorado Medical Society

Disclosure: Nothing to disclose.

Chief Editor
Jorge I de la Torre, MD, FACS Professor of Surgery and Physical Medicine and Rehabilitation, Chief, Division of Plastic Surgery, Residency Program Director, University of Alabama at Birmingham School of Medicine; Director, Center for Advanced Surgical Aesthetics

Jorge I de la Torre, MD, FACS is a member of the following medical societies: American Association of Plastic Surgeons, American Burn Association, American College of Surgeons, American Medical Association, American Society for Laser Medicine and Surgery, American Society for Reconstructive Microsurgery, American Society of Maxillofacial Surgeons, American Society of Plastic Surgeons, Association for Academic Surgery, and Medical Association of the State of Alabama

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Additional Contributors
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References

1. Bornbaum CC, Fung K, Franklin JH, Nichols A, Yoo J, Doyle PC. A descriptive analysis of the relationship between quality of life and distress in individuals with head and neck cancer. *Support Care Cancer*. Nov 30 2011;[Medline].

2. Maurer J, Hipp M, Schäfer C, Kölbl O. Dysphagia : Impact on quality of life after radio(chemo)therapy of head and neck cancer. *Strahlenther Onkol*. Nov 2011;187(11):744-749. [Medline].

3. Stiefel M, Shaner A, Schaefer SD. The Edwin Smith Papyrus: the birth of analytical thinking in medicine and otolaryngology. *Laryngoscope*. 2006;116(2):182-8.

4. Whitaker IS, Karoo RO, Spyrou G, Fenton OM. The birth of plastic surgery: the story of nasal reconstruction from the Edwin Smith Papyrus to the twenty-first century. *Plast Reconstr Surg*. 2007;120(1):327-36. [Medline].

5. Morris M, Unhold G. Use of flaps in reconstructive surgery of the head and neck. In: LJ P. *Principle of Oral and Maxillofacial Surgery*. Philadelphia, Pa: Lippincott; 1992:947.

6. Daniel RK, Taylor GI. Distant transfer of an island flap by microvascular anastomoses. A clinical technique. *Plast Reconstr Surg*. Aug 1973;52(2):111-7. [Medline].

7. Bakamjian VY. A two-stage method for pharyngoesophageal reconstruction with a primary pectoral skin flap. *Plast Reconstr Surg*. Aug 1965;36:173-84. [Medline].

8. Panje WR, Bardach J, Krause CJ. Reconstruction of the oral cavity with a free flap. *Plast Reconstr Surg*. Oct 1976;58(4):415-8. [Medline].

9. Harashina T, Fujino T, Aoyagi F. Reconstruction of the oral cavity with a free flap. *Plast Reconstr Surg*. Oct 1976;58(4):412-4. [Medline].

10. Ariyan S. The pectoralis major myocutaneous flap. A versatile flap for reconstruction in the head and neck. *Plast Reconstr Surg*. Jan 1979;63(1):73-81. [Medline].

11. American Cancer Society. Cancer Facts & Figures. American Cancer Society Web site. Available at http://www.cancer.org/docroot/STT/stt_0_2008.asp?sitearea=STT&level=1. Accessed February 20, 2009.

12. Hurvitz KA, Kobayashi M, Evans GR. Current options in head and neck reconstruction. *Plast Reconstr Surg*. Oct 2006;118(5):122e-133e. [Medline].

13. Renner G. Reconstruction of the lip. In: Baker S. *Local Flaps in Facial Reconstruction*. 2nd ed. Philadelphia, Pa: Mosby; 2007:475-525.

14. Abbe R. A new plastic operation for the relief of deformity due to double harelip. *Plast Reconstr Surg*. Nov 1968;42(5):481-3. [Medline].

15. Ong WC, Lim J, Lim TC. A modification of the bilobed and Karapandzic flap used for reconstruction of the lower lip. *Plast Reconstr Surg*. Jun 2005;115(7):2154-5. [Medline].

16. Anvar BA, Evans BC, Evans GR. Lip reconstruction. *Plast Reconstr Surg*. Sep 15 2007;120(4):57e-64e. [Medline].

17. Ozdemir R, Ortak T, Kocer U, Celebioglu S, Sensoz O, Tiftikcioglu YO. Total lower lip reconstruction using sensate composite radial forearm flap. *J Craniofac Surg*. May 2003;14(3):393-405. [Medline].

18. McConnel FM, Pauloski BR, Logemann JA, Rademaker AW, Colangelo L, Shedd D, et al. Functional results of primary closure vs flaps in oropharyngeal reconstruction: a prospective study of speech and swallowing. *Arch Otolaryngol Head Neck Surg*. Jun 1998;124(6):625-30. [Medline].

19. Yu P. Characteristics of the anterolateral thigh flap in a Western population and its application in head and neck reconstruction. *Head Neck*. Sep 2004;26(9):759-69. [Medline].

20. Vos JD, Burkey BB. Functional outcomes after free flap reconstruction of the upper aerodigestive tract. *Curr Opin Otolaryngol Head Neck Surg*. Aug 2004;12(4):305-10. [Medline].

21. Chana JS, Wei FC. A review of the advantages of the anterolateral thigh flap in head and neck reconstruction. *Br J Plast Surg*. Oct 2004;57(7):603-9. [Medline].

22. Huang YC, Leong CP, Pong YP, Liu TY, Kuo YR. Functional assessment of donor-site morbidity after harvest of a fibula chimeric flap with a sheet of soleus muscle for mandibular composite defect reconstruction. *Microsurgery*. Jan 2012;32(1):20-5. [Medline].

23. Bodde EW, de Visser E, Duysens JE, Hartman EH. Donor-site morbidity after free vascularized autogenous fibular transfer: subjective and quantitative analyses. *Plast Reconstr Surg*. Jun 2003;111(7):2237-42. [Medline].

24. Dassonville O, Poissonnet G, Chamorey E, Vallicioni J, Demard F, Santini J. Head and neck reconstruction with free flaps: a report on 213 cases. *Eur Arch Otorhinolaryngol*. Jan 2008;265(1):85-95. [Medline].

25. El-Marakby HH. The reliability of pectoralis major myocutaneous flap in head and neck reconstruction. *J Egypt Natl Canc Inst*. Mar 2006;18(1):41-50. [Medline].

26. Milenovic A, Virag M, Uglesic V, Aljinovic-Ratkovic N. The pectoralis major flap in head and neck reconstruction: first 500 patients. *J Craniomaxillofac Surg*. Sep 2006;34(6):340-3. [Medline].

27. Chen WL, Li JS, Yang ZH, Huang ZQ, Wang JU, Zhang B. Two submental island flaps for reconstructing oral and maxillofacial defects following cancer ablation. *J Oral Maxillofac Surg*. Jun 2008;66(6):1145-56. [Medline].

28. Song R, Song Y, Yu Y, Song Y. The upper arm free flap. *Clin Plast Surg*. Jan 1982;9(1):27-35. [Medline].

29. Bardsley AF, Soutar DS, Elliot D, Batchelor AG. Reducing morbidity in the radial forearm flap donor site. *Plast Reconstr Surg*. Aug 1990;86(2):287-92; discussion 293-4. [Medline].

30. Wei FC, Jain V, Celik N, Chen HC, Chuang DC, Lin CH. Have we found an ideal soft-tissue flap? An experience with 672 anterolateral thigh flaps. *Plast Reconstr Surg*. Jun 2002;109(7):2219-26; discussion 2227-30. [Medline].

31. Hanasono MM, Skoracki RJ, Silva AK, Yu P. Adipofascial perforator flaps for "aesthetic" head and neck reconstruction. *Head Neck*. Oct 2011;33(10):1513-9. [Medline].

32. Kimata Y, Uchiyama K, Ebihara S, Kishimoto S, Asai M, Saikawa M. Comparison of innervated and noninnervated free flaps in oral reconstruction. *Plast Reconstr Surg*. Oct 1999;104(5):1307-13. [Medline].

33. Koshima I, Fukuda H, Yamamoto H, Moriguchi T, Soeda S, Ohta S. Free anterolateral thigh flaps for reconstruction of head and neck defects. *Plast Reconstr Surg*. Sep 1993;92(3):421-8; discussion 429-30. [Medline].

34. Kimura N, Satoh K, Hosaka Y. Microdissected thin perforator flaps: 46 cases. *Plast Reconstr Surg*. Dec 2003;112(7):1875-85. [Medline].

35. Alkureishi LW, Ross GL. Thinning of the anterolateral thigh flap: unpredictable results. *Plast Reconstr Surg*. Aug 2006;118(2):569-70. [Medline].

36. Kimata Y, Uchiyama K, Ebihara S, Sakuraba M, Iida H, Nakatsuka T, et al. Anterolateral thigh flap donor-site complications and morbidity. *Plast Reconstr Surg*. Sep 2000;106(3):584-9. [Medline].

37. Huang CH, Chen HC, Huang YL, Mardini S, Feng GM. Comparison of the radial forearm flap and the thinned anterolateral thigh cutaneous flap for reconstruction of tongue defects: an evaluation of donor-site morbidity. *Plast Reconstr Surg*. Dec 2004;114(7):1704-10. [Medline].

38. Kuo YR, Jeng SF, Kuo MH, Huang MN, Liu YT, Chiang YC. Free anterolateral thigh flap for extremity reconstruction: clinical experience and functional assessment of donor site. *Plast Reconstr Surg*. Jun 2001;107(7):1766-71. [Medline].

39. Wei FC, Demirkan F, Chen HC, Chuang DC, Chen SH, Lin CH. The outcome of failed free flaps in head and neck and extremity reconstruction: what is next in the reconstructive ladder?. *Plast Reconstr Surg*. Oct 2001;108(5):1154-60; discussion 1161-2. [Medline].

40. Genden EM, Wallace D, Buchbinder D, Okay D, Urken ML. Iliac crest internal oblique osteomusculocutaneous free flap reconstruction of the postablative palatomaxillary defect. *Arch Otolaryngol Head Neck Surg*. Jul 2001;127(7):854-61. [Medline].

41. Rieger JM, Zalmanowitz JG, Li SY, Sytsanko A, Harris J, Williams D, et al. Functional outcomes after surgical reconstruction of the base of tongue using the radial forearm free flap in patients with oropharyngeal carcinoma. *Head Neck*. Nov 2007;29(11):1024-32. [Medline].

42. Seikaly H, Rieger J, Wolfaardt J, Moysa G, Harris J, Jha N. Functional outcomes after primary oropharyngeal cancer resection and reconstruction with the radial forearm free flap. *Laryngoscope*. May 2003;113(5):897-904. [Medline].

43. Yagi S, Kamei Y, Nakayama B, Toriyama K, Torii S. A new design for free flap reconstruction of the tongue and oropharynx. *J Reconstr Microsurg*. Apr 2008;24(3):211-9. [Medline].

44. Clark JR, Gilbert R, Irish J, Brown D, Neligan P, Gullane PJ. Morbidity after flap reconstruction of hypopharyngeal defects. *Laryngoscope*. Feb 2006;116(2):173-81. [Medline].

45. Genden EM, Kaufman MR, Katz B, Vine A, Urken ML. Tubed gastro-omental free flap for pharyngoesophageal reconstruction. *Arch Otolaryngol Head Neck Surg*. Jul 2001;127(7):847-53. [Medline].

46. Mureau MA, Posch NA, Meeuwis CA, Hofer SO. Anterolateral thigh flap reconstruction of large external facial skin defects: a follow-up study on functional and aesthetic recipient- and donor-site outcome. *Plast Reconstr Surg*. Apr 2005;115(4):1077-86. [Medline].

47. Evans GR, Schusterman MA, Kroll SS, Miller MJ, Reece GP, Robb GL, et al. The radial forearm free flap for head and neck reconstruction: a review. *Am J Surg*. Nov 1994;168(5):446-50. [Medline].

48. O'Malley BW Jr, Weinstein GS, Snyder W, Hockstein NG. Transoral robotic surgery (TORS) for base of tongue neoplasms. *Laryngoscope*. Aug 2006;116(8):1465-72. [Medline].

49. Hoffmann TK, Bier H, Whiteside TL. Targeting the immune system: novel therapeutic approaches in squamous cell carcinoma of the head and neck. *Cancer Immunol Immunother*. Dec 2004;53(12):1055-67. [Medline].

50. Harrington KJ, Nutting CM, Pandha HS. Gene therapy for head and neck cancer. *Cancer Metastasis Rev*. Jan 2005;24(1):147-64. [Medline].

51. Baek SM. Two new cutaneous free flaps: the medial and lateral thigh flaps. *Plast Reconstr Surg*. Mar 1983;71(3):354-65. [Medline].

52. Bailey BJ, Calhoun KH, Neely JG. Atlas of Head and Neck Surgery-Otolaryngology. Lippincott Williams & Wilkins;1996.

53. Baker SR. Regional flaps in facial reconstruction. *Otolaryngol Clin North Am*. Oct 1990;23(5):925-46. [Medline].

54. Cheney ML, Varvares MA, Nadol JB Jr. The temporoparietal fascial flap in head and neck reconstruction. *Arch Otolaryngol Head Neck Surg*. Jun 1993;119(6):618-23. [Medline].

55. Cummings CW. Otolaryngology Head and Neck Surgery. Singular Publishing Group;1998.

56. Cummings CW, Eisele DW, Coltrera MD. Lower trapezius myocutaneous island flap. *Arch Otolaryngol Head Neck Surg*. Oct 1989;115(10):1181-5. [Medline].

57. Frodel JL Jr, Funk GF, Capper DT, et al. Osseointegrated implants: a comparative study of bone thickness in four vascularized bone flaps. *Plast Reconstr Surg*. Sep 1993;92(3):449-55; discussion 456-8. [Medline].

58. Hidalgo DA. Fibula free flap: a new method of mandible reconstruction. *Plast Reconstr Surg*. Jul 1989;84(1):71-9. [Medline].

59. Jabaley ME, Orcutt TW, Clement RL. Applications of the Karapandzic principle of lip reconstruction after excision of lip cancer. *Am J Surg*. Oct 1976;132(4):529-32. [Medline].

60. Schuller DE. Latissimus dorsi myocutaneous flap for massive facial defects. *Arch Otolaryngol*. Jul 1982;108(7):414-7. [Medline].

61. Schusterman MA, Reece GP, Miller MJ, Harris S. The osteocutaneous free fibula flap: is the skin paddle reliable?. *Plast Reconstr Surg*. Nov 1992;90(5):787-93; discussion 794-8. [Medline].

62. Song R, Gao Y, Song Y, Yu Y, Song Y. The forearm flap. *Clin Plast Surg*. Jan 1982;9(1):21-6. [Medline].

63. Sullivan MJ, Carroll WR, Baker SR. The free scapular flap for head and neck reconstruction. *Am J Otolaryngol*. Sep-Oct 1990;11(5):318-27. [Medline].

64. Sultan MR, Coleman JJ 3d. Oncologic and functional considerations of total glossectomy. *Am J Surg*. Oct 1989;158(4):297-302. [Medline].

65. Swanson NA, Grekin RC, Baker SR. Mohs surgery: techniques, indications, and applications in head and neck surgery. *Head Neck Surg*. Nov-Dec 1983;6(2):683-92. [Medline].

66. Urken ML. The restoration or preservation of sensation in the oral cavity following ablative surgery. *Arch Otolaryngol Head Neck Surg*. Jun 1995;121(6):607-12. [Medline].

67. Urken ML, Buchbinder D, Weinberg H, et al. Primary placement of osseointegrated implants in microvascular mandibular reconstruction. *Otolaryngol Head Neck Surg*. Jul 1989;101(1):56-73. [Medline].

68. Urken ML, Weinberg H, Buchbinder D, et al. Microvascular free flaps in head and neck reconstruction. Report of 200 cases and review of complications. *Arch Otolaryngol Head Neck Surg*. Jun 1994;120(6):633-40. [Medline].

69. Urken ML, Weinberg H, Vickery C, Biller HF. The neurofasciocutaneous radial forearm flap in head and neck reconstruction: a preliminary report. *Laryngoscope*. Feb 1990;100(2 Pt 1):161-73. [Medline].

70. Urken ML, Weinberg H, Vickery C, et al. Oromandibular reconstruction using microvascular composite free flaps. Report of 71 cases and a new classification scheme for bony, soft- tissue, and neurologic defects. *Arch Otolaryngol Head Neck Surg*. Jul 1991;117(7):733-44. [Medline].

71. Urken ML, Weinberg H, Vickery C, et al. The combined sensate radical forearm and iliac crest free flaps for reconstruction of significant glossectomy-mandibulectomy defects. *Laryngoscope*. May 1992;102(5):543-58. [Medline].

72. Zitsch RP 3d. Carcinoma of the lip. *Otolaryngol Clin North Am*. Apr 1993;26(2):265-77. [Medline].