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## **Introduction**

The oropharynx is a three dimensional structure bounded anteriorly by the anterior pillars of the pharyngeal fauces (the palatoglossus muscle), the circumvallate papillae (sulcus terminales) or the junction of the hard and soft palates. Posterior and lateral boundaries are formed by the muscular pharyngeal wall (superior and middle constrictors). The superior extent is the level of the soft palate (some define this as the level of the hard palate). The inferior extent is the level of the base of tongue (level of the hyoid). The oropharynx is further subdivided into five areas. These include lateral pharyngeal walls, tonsillar regions, posterior wall, base of tongue, and soft palate.

The oropharynx is an anatomical area with many functions. It plays an important part in all the functions of the upper aerodigestive tract. Structures in this area participate in deglutition, respiration, and phonation. Other functions include airway protection, taste sensation, and immunologic surveillance. The oropharynx participates in deglutition by propelling the food bolus into the hypopharynx. Once the bolus has been prepared in the oral cavity, it is passed posteriorly by the action of the oral tongue. Elevation of the base of tongue and sensory afferents from the tongue, pharyngeal walls, and vallecula trigger the pharyngeal phase of swallowing (CN IX, X). The pharyngeal phase is characterized by elevation of the larynx (which shortens the pharynx), and closure of the velopharyngeal valve. The soft palate is tensed, elevated and angled to seal the nasopharynx as the bolus advances. This is accomplished by a contraction of the palatopharyngeus, tensor veli palatine, and levator veli palatine. The muscles of the base of tongue and lateral tonsillar pillars also contract, which keeps the bolus from spilling back into the oral cavity. As the base of tongue pushes posteriorly, the pharyngeal walls contract and the larynx is elevated. Coordination of the pharyngeal phase of deglutition prevents dysphagia and aspiration.

The oropharynx participates in respiration by providing a pathway for both nasal and oral respiration. Sound produced by the larynx is shaped by structures of the oropharynx, as well. The surface anatomy of the oropharynx and oral cavity determine resonance characteristics of voice. "Hyponasal voice" is a result of altered resonance characteristics in effect when velopharyngeal closure is not achieved. Elevation of the soft palate is especially important for

production of the “k” sound, but participates in the formation of many other consonants and vowels. Oropharyngeal sensation is essential for airway protection, and provides taste sensation, as well. Finally, the lymphoid tissues of Waldeyer’s ring are thought to serve as one portion of the immunologic surveillance system.

## **Anatomy**

The soft palate is composed of a fibrous skeleton (palatine aponeurosis) and several muscles covered by mucosa. Minor salivary glands and taste organs are found along the surface of this structure. The muscles found in the soft palate include the levator veli palatini, tensor veli palatini, palatopharyngeus, palatoglossus, and musculus uvulae. The levator veli palatini is important for elevation of the soft palate during speech and swallowing and pulls the palate posteriorly toward the pharyngeal wall. The tensor veli palatini tenses the soft palate and opens the ipsilateral Eustachian tube. The palatoglossus and palatopharyngeus form the anterior and posterior tonsillar arches (respectively) and function to separate the oropharynx from the oral cavity during deglutition. The soft palate has rich lymphatic drainage. It drains to bilateral cervical lymphatic systems. V2 and V3 provide the sensation and motor innervation of the soft palate.

The posterior and lateral walls of the oropharynx are formed by the superior and middle pharyngeal constrictors. The superior constrictor is suspended from the skull base, the medial pterygoid plate, the pterygomandibular raphe, the mylohyoid line of the mandible and the lateral tongue. The anterior attachments of the middle constrictor are the hyoid bone and the stylohyoid ligament. Both muscles are attached to the cervical vertebrae posteriorly. The oropharynx is lined by a nonkeratinizing stratified squamous epithelium which is tightly adherent to an underlying fascial layer called the pharyngobasilar fascia. This fascia lies just medial to the constrictor muscles.

These pharyngeal muscles are innervated by the pharyngeal plexus which is composed of nerve fibers from the glossopharyngeal and vagus nerves. CN IX provides proprioception and pain innervation. The vagus nerve provides the motor contribution and a small amount of sensation. When a food bolus traverses the tongue it stimulates neural reflexes which initiate the contraction of the pharyngeal constrictor muscles. This contraction decreases the size of the oropharynx and helps to propel the bolus into the hypopharynx. These muscles are not involved in maintaining airway patency. The oropharynx is surrounded on three sides by potential fascial compartments which lie just outside the pharyngeal constrictors. These spaces are known as the retropharyngeal, and bilateral parapharyngeal spaces. These can serve as routes for spread of cancer.

A series of lymphoid structures surround the oropharyngeal opening. This ring of tissues (Waldeyer’s ring) includes the palatine tonsils, lingual tonsils, and adenoid tissues. The palatine and lingual tonsil tissues are found within the oropharynx. The palatine tonsils are paired and usually oval in shape. They lie between the mucosal folds formed by the palatoglossus and palatopharyngeus muscles. Their deep surface is adjacent to the superior constrictor muscle and separated by a thin fascial plane. Blood supply to the palatine tonsils is supplied by the ascending pharyngeal, ascending palatine, and branches from the lingual and facial arteries, all of

which are branches of the external carotid artery. The internal carotid artery is located 2 cm posterior and lateral to the deep surface of the tonsil.

The base of tongue is an important structure for swallowing and speech. The tongue base provides the primary force for movement of food from the oropharynx, around the epiglottis, and into the hypopharynx. The sulcus terminalis (a V-shaped furrow on the dorsal surface) divides the tongue into its oral and pharyngeal components. Its apex is marked by the foramen cecum. The tongue is a muscular organ covered by a thin layer of mucosa. There are two types of muscle which comprise the tongue—intrinsic and extrinsic. Intrinsic muscles have no outside attachments whereas extrinsic muscles have attachments to structures outside the tongue. Extrinsic tongue muscles include the genioglossus, styloglossus, chondroglossus and hyoglossus. Embryologically, the muscles on each side of the oral tongue develop separately and then fuse in the midline. This near-bloodless plane can be used for surgical access to the base of tongue. Taste papillae, serous and mucus glands dot the tongue's dorsal surface. Irregular lymphoid tissue lies at the tongue base and is referred to as the lingual tonsils.

The vallecula is the area between the tongue base and the epiglottis. Irregular lymphoid tissue lies at the base of the tongue in this trough-shaped area. These “lingual tonsils” are part of the ring of lymphoid tissues that surrounds the oropharynx. The epiglottis is composed of a long spoon-like cartilage skeleton covered with mucosa. It serves as the posterior border of the vallecula and helps to direct food bolus around the larynx and into the piriform sinuses. Its cartilaginous makeup allows it to bend with elevation of the larynx and retrusion of the tongue base. As it bends posteriorly it covers the larynx and serves to direct food around it. After the tongue relaxes it quickly springs back into its upright position. A fibrous connective tissue structure runs between the hyoid bone anteriorly and the epiglottis posteriorly. This structure is called the hyoepiglottic ligament. It is an important barrier to the spread of cancer from the tongue base into the deep compartments of the larynx, preepiglottic and paraglottic spaces. It also serves as an important surgical plane for precise entry into the vallecula. It condenses medially to form the median glossoepiglottic fold.

The mandible, though not a structure of the oropharynx, is an important structure to understand when discussing surgical approaches to the oropharynx. It is a U-shaped bone composed of two external cortices and an internal marrow space. The temporomandibular joint serves as its pivot point. The mandible provides insertion for muscles and contributes the to functions of articulation, mastication, and deglutition. The vascular supply to the mandible comes from the inferior alveolar vessels, which run through the inferior alveolar canal, as well as from the periosteal, lingual and facial arteries. The inferior alveolar vessels anastomose across the mandibular symphysis. The majority of mandibular blood flow is from this medullary circulation. Less than 25% of cortical vascular supply is from the periosteal arterioles. Surgical exposure often disrupts supply from the lingual and facial vessels. Extensive periosteal stripping can lead to decreased arterial supply as well as venous stasis.

The oropharynx has a rich lymphatic drainage system. The majority of the lymphatic drainage is to levels I, II and III cervical lymph nodes. Midline structures such as the base of tongue, soft palate, and posterior pharyngeal wall drain to both sides of the neck. The tonsillar area and posterior pharyngeal wall also drain to the retropharyngeal nodes. Blood supply to the oropharynx is via several branches of the external carotid artery.

## Approaches to the Oropharynx

Surgery in the oropharynx is a complicated proposal. The oropharynx is integral to many of the vital functions of the aerodigestive tract and is surrounded by an intricate network of important structures. Despite these challenges, surgery for neoplasms of the oropharynx should attempt to meet five goals which include complete tumor control, adequate exposure, preservation of function, minimization of cosmetic deformity, and simplicity of technique. In order to achieve these purposes head and neck surgeons have devised several surgical approaches to the oropharynx.

### Approaches through the oral cavity

Approaches to the oropharynx via the oral cavity are differentiated by how the mandible is involved. The transoral approach does not involve the mandible, whereas median labio-mandibulo glossotomy, midline mandibulotomy, lateral mandibulotomy, and mandibulectomy involve sectioning of the mandible.

#### Transoral

This approach is perhaps the most direct, and for appropriate lesions, the easiest approach. It is appropriate for lesions of the faucial arches, tonsils, and upper posterior pharyngeal wall. It is recommended that only small lesions (1.5 cm or less) of the posterior wall be addressed transorally, as deep margin dissection can be difficult with larger lesions. The patient is positioned on the operating table and the mouth opened with a Dingman mouth gag (authors differ on which mouth gag they prefer, but adequate exposure is a necessity.) The soft tissues of the soft palate can be retracted by palatal stay sutures or red rubber catheters passed through the nose and brought out through the mouth. Excision of the lesion is performed using electrocautery, knife, or laser. Care is taken to ensure avoid beveling into the lesion during excision. The anatomic limits of surgical resection via the transoral approach include the maxilla anterosuperiorly (although a cuff of bone can be taken, if necessary), the mandibular ramus laterally, tongue base inferiorly, external carotid and branches inferolaterally. A pharyngotomy can be performed whenever the demands of resection are more than can be afforded by this approach. The advantages of this approach include its simplicity, maintenance of mandibular anatomic integrity, and flexibility to proceed to more involved approaches, if necessary. The disadvantages include limited exposure.

The **pull-through** procedure involves dropping the contents of the oral cavity/oropharynx into the neck by releasing these structures from their attachments to the mandible. This allows fairly good access to lesions of the oropharynx. The advantages include intact lip sensation, good facial cosmesis, and an intact mandible. Disadvantages include compromised exposure, loss of sensation over the floor of mouth and tongue bilaterally, and possible need for additional approaches to improve visualization. Difficulty maintaining continuity between tumor specimen and neck dissections as well as poor visualization secondary to brisk bleeding can also complicate this approach.

The procedure is preceded by performing bilateral neck dissections of at least level I. This will allow identification of the hypoglossal nerve and many of the extrinsic muscles of the tongue. With the hypoglossal nerve protected the lingual mucosa of the floor of mouth is incised

on both sides, taking care to leave a cuff of tissue on the mandible to facilitate closure. The lingual nerve and sublingual salivary gland are kept with the mandibular tissues. The extrinsic muscles of the tongue attached to the mandible are incised and the tongue is pulled down and anteriorly through the neck. Excision of the lesion is undertaken.

### **Mandibulotomy**

Although rarely used today, the **median labio-mandibulo glossotomy** (Trotter's Procedure), is useful for lesions of the base of tongue, upper posterior pharyngeal wall, soft palate, and nasopharynx. It can be combined with a palatal split for more superior exposure. This approach preserves all sensation and has minimal postoperative morbidity. It is best for midline lesions as it allows little lateral exposure. It does require a lip-split mandibulotomy, and tracheostomy (secondary to significant tongue edema).

A midline mandibulotomy is performed by exposing the mandible via a lip-splitting incision. Most authors curve the incision around the chin pad in order to camouflage the surgical scar. Marks can be placed in the vermilion border with the back edge of a knife blade to facilitate precise closure. The mucosal incision is also completed and taken to the level of the mandible. Soft tissue flaps are elevated to the level of the mental foramen bilaterally taking care to avoid injury to the mental nerve. The periosteum is elevated only in the area where fixation plates will be placed. Once this is done plates are placed and appropriate holes drilled (this results in exact recreation of occlusion during reconstruction), but screws are not placed. The plate, appropriately shaped, is then marked in such a way as to assure correct orientation when used later in the case. A mandibulotomy is performed using thin blade saw (gigli saw can also be used). Authors do not agree on the location and shape of the mandibulotomy, but generally it is placed either in the midline between the two central incisors or in the paramedian position between the lateral incisor and the canine tooth (see discussion of mandibulotomy below).

The tongue is then incised in the midline. This is usually a fairly bloodless plane. The incision is carried as far posterior as necessary to provide exposure. The entire tongue can be split to access more posterior lesions. After resection of the lesion the tongue is reapproximated with a layered closure. The mandible is plated using the previously fashioned plate and screw holes. Finally the lip and skin incisions are closed.

One of the more commonly used approaches to the oropharynx is the **lip-split mandibulotomy or mandibular swing**. This procedure provides excellent exposure for lesions of the entire tongue, soft palate, posterior pharyngeal wall, and tonsillar fossae. The main advantages to this approach is the amount of exposure afforded and preservation of lower lip sensation, as well as the ability to keep the neck dissection in continuity with the tumor specimen. The disadvantages include the morbidity of mandibulotomy, loss of sensation to the lateral tongue and floor of mouth secondary to disruption of the lingual nerve, division of muscles attached to the anterior and medial aspects of the mandible, and poor exposure of the inferior posterior pharyngeal wall. If necessary, a cervical pharyngotomy can be combined with this approach to provide exposure to the lower posterior wall. Even this combined exposure, however, can be compromised by the constraints of preserving the hypoglossal nerve. One other disadvantage is that if tumor is found to be invading the mandible during the surgery more of the mandible will have to be sacrificed to achieve clear tumor margins than would be needed if a segmental mandibulectomy or lateral mandibulotomy had been performed.

This approach is usually accompanied by a neck dissection of some sort. Dissection of level I is usually necessary, even if a formal neck dissection is not performed. This is done to identify and protect the hypoglossal nerve. Once this structure has been traced into the tongue a lip-split mandibulotomy is performed as previously described. After the mandible has been split the lingual floor of mouth mucosa on the side of the lesion is incised. The dissection is carried deep taking care to leave a cuff of tissue on the mandible for eventual closure. The mylohyoid and digastric muscles are divided, leaving a cuff of tissue on either side for reapproximation. The mandibular swing is accomplished as the incision is carried posteriorly along the floor of mouth and the mandible is retracted laterally. The hypoglossal nerve is protected medially with the lingual nerve preserved on the mandible side. Several branches of the lingual nerve must be incised during the posterior dissection. The sublingual gland is also preserved on the mandibular side. The incision can be carried posteriorly to the anterior aspect of the ramus with division of the pterygoid muscles if necessary for exposure. The retromolar trigone and infratemporal fossa can also be addressed via this approach. After resection of the tumor the paralingual mucosa is reapproximated as are the deep muscles of the tongue and floor of mouth. The usual closure of the mandibulotomy and lip-split are performed.

Some authors describe this approach using a visor skin flap (cheek flap) which is dissected superiorly off the mandible before performing the mandibulotomy. The advantage of this approach is the avoidance of a lip-splitting incision. However, sensation to the lower lip is sacrificed, as is the extent of exposure possible. Decreased viability with postoperative XRT and diminution of blood supply to the mandible are also associated risks with this approach.

A **lateral mandibulotomy** can be used to access lesions of the tonsil, base of tongue, parapharyngeal space, and upper posterior pharyngeal wall. The mandibulotomy is usually made posterior to the mental foramen which results in disruption of the inferior alveolar nerve and vessels. The lingual nerve is also usually divided. Both nerves should be identified, if possible, for possible repair during closure. As the mental nerve is usually sacrificed with this approach, a visor flap is possible, though a lip-split incision may afford better exposure. As previously described, a plate is fitted, and holes are drilled before completion of the mandibulotomy. Once the mandibulotomy has been performed the soft tissues are released medially so as to swing the mandible laterally. Floor of mouth mucosal incisions are made with relative assurance that the hypoglossal will not be injured as the incision is usually posterior to mylohyoid. After resection of the tumor closure proceeds as previously discussed with some authors recommending repair of the lingual and alveolar nerves.

This approach is no longer commonly used. The sacrifice of lip and tooth sensation, tongue sensation, and the risk of substantially compromising the mandibular blood supply are generally felt to outweigh any benefits this approach may offer. The midline mandibulotomy usually offers equal surgical exposure with far fewer morbidities.

Finally, a **mandibulectomy**, or composite resection, is used when tumor is found to be invading the mandible. Advanced tumors of the tongue, tonsil, and soft palate may all be addressed via this approach. Usually patients with tumors of the oropharynx that invade the mandible have metastatic neck disease which is addressed with neck dissections. A lip-split incision is then performed (although a visor flap can also be used) and a cheek flap is developed. The mental nerve is sacrificed and the periosteum elevated from the level of the mental nerve to

the ascending ramus. The buccal mucosa is incised posteriorly to the retromolar trigone. When elevating the posterior aspect of the cheek flap it is important to stay close to the ramus of the mandible as a more lateral excursion can injure the facial nerve. Once the mandible has been exposed a mandibular reconstruction plate is fashioned with holes drilled on either side of the proposed mandibulectomy. There should be room enough for three holes on either side. If free flap bony reconstruction is to be performed a reconstruction bar may not be necessary. Once the bony cuts are made (with adequate tumor margins) the lesion is excised as the mandibular segment is grasped and rotated inferiorly and laterally. These cuts almost always involve branches of the external carotid system. These vessels must be ligated as they are discovered. Care is taken to avoid injury to the main trunk of the external carotid or the hypoglossal nerve during dissection. The pterygoid plexus can cause troublesome bleeding when high transection of the mandible is necessary. This may require packing and figure-of-eight sutures to achieve hemostasis. Wound closure depends on the chosen method of reconstruction.

### **Approaches to the oropharynx through the neck**

Surgical approaches to the oropharynx through the neck were initially developed subsequent to experience treating wounds caused by suicide attempts and slashings. Physicians realized that the pharynx and larynx could be reached through the neck with minimal injury to vital neurovascular structures. These procedures have been alternatively endorsed and discouraged over the past century. The concern for clear tumor margins with a relatively blind entry into the pharynx was the most serious criticism of these approaches. After techniques were developed that ensured precise entry into the pharynx, surgeons once again began to approach the oropharynx through the neck. Many authors now laud these techniques either alone or in combination with transoral approaches to treat lesions of the oropharynx. Several authors have shown that transcervical resection of oropharyngeal lesions when compared with traditional anterior approaches can result in similar survival and tumor-free margin data while significantly decreasing morbidity. Agrawal compared combined transoral and transhyoid approach to the traditional approach (mandibulotomy) and found that long-term outcomes were similar, but that fistula formation and mandible problems were significantly less for those who underwent a combined approach.

#### **Anterior pharyngotomy**

The **suprahyoid approach** to the oropharynx is best used for exposure of lesions of the tongue-base, faucial arches, suprahyoid epiglottis, and low posterior pharyngeal wall lesions that cannot be excised transorally. Lesions should not involve both lingual arteries or the mandible.

An apron flap is raised and the hyoid bone identified. Electrocautery is used to dissect the suprahyoid musculature from the hyoid bone. The hyoid is grasped with an Alice clamp and retracted inferiorly. The intrinsic muscles of the tongue can then be bluntly dissected from the hyoid and the hyoepiglottic ligament. The condensation of fibers in this ligament (the median glossoepiglottic fold) will then be identifiable. This is the point of precise entry into the oropharynx. Identification of this structure avoids unintentional violation of tumor or laryngeal structures. Once the initial pharyngotomy has been made, it can be widened so that the lesion may be respected under direct vision. If the lesion involves the tongue base, grasping the tongue base and pulling it anteriorly through the pharyngotomy will facilitate visualization. After resection of the lesion, resuspension of the hyoid is important to avoid postoperative aspiration

and swallowing dysfunction. This can be accomplished by reapproximating the suprahyoid musculature or with non-absorbable suspension sutures from the mandible. A tracheostomy is not always necessary.

The **subhyoid approach** is useful for lesions of the tongue base that have either directly invaded the hyoid bone, or have neck metastases that involve the hyoid bone. In order to excise the involved hyoid bone, an infrahyoid incision is made which separates the infrahyoid muscles from the hyoid bone. The involved portion of the hyoid bone is resected with the tumor and the procedure is carried out in a fashion similar to a suprahyoid pharyngotomy. A tracheostomy is not always necessary.

The **high lateral pharyngotomy** approach is not routinely used, as it offers little advantage over an anterior pharyngotomy and requires blind entry into the pharynx. It also brings increased risk to the superior laryngeal nerve, hypoglossal nerve and the lingual artery. Moreover, exposure is limited when those horizontally-oriented structures are preserved. It is usually performed in conjunction with a pull-through approach and neck dissection in order to improve tumor exposure. This is done by extending the intraoral incisions into the lateral pharynx while protecting the important neurovascular structures in the neck.

The **low lateral pharyngotomy** approach is rarely used alone. It allows access to the lower lateral and posterior pharyngeal wall. It can be combined with mandibulotomy or anterior pharyngotomy for wide exposure of the oropharynx. Lesions that involve the oropharynx and spread into the hypopharynx may be amenable to this approach. Unfortunately, the lateral pharyngotomy requires a blind entry into the pharynx. As with the high pharyngotomy, it also risks injury to the superior laryngeal nerve, hypoglossal nerve and lingual artery. Lesions of the superior oropharynx are also not well exposed with this approach.

A low lateral pharyngotomy is performed by first defining the structures of the neck by neck dissection. The greater and lesser cornu of the hyoid bone are exposed and the greater cornu is skeletonized and often resected. The upper portion of the thyroid cartilage is also identified and can be removed (upper lateral 1/3) for exposure after the inferior constrictor is divided. The pyriform sinus mucosa is elevated off the thyroid cartilage and a lateral pharyngotomy is performed. Laryngoscopic visualization can be used to direct the pharyngotomy. Once the tumor is excised, the pharyngotomy can be primarily closed in most cases. With more extensive resections a flap may be necessary to achieve closure. A tracheostomy is performed.

### **Combination of pharyngotomy with partial or total laryngectomy**

A **suprahyoid supraglottic laryngotomy** is used to excise tongue-base lesions which are adjacent to or minimally invading the vallecula. The hyoid bone is preserved with this approach. The approach can be combined with a pull-through procedure to deal with lesions of the oropharynx which do not involve both lingual arteries or the mandible.

The dissection is similar to a suprahyoid pharyngotomy except that after identification of the hyoepiglottic ligament it is incised at its hyoid origin and the hyoid is retracted inferiorly. The preepiglottic fat is identified. Palpation in this area allows identification of the lateral edge of the epiglottis. A supraglottic laryngotomy can then be performed between the epiglottis and

the false vocal folds. The laryngotomy is then widely opened to facilitate direct visualization while excising the tongue base tumor in continuity with the epiglottis. The hyoepiglottic ligament, preepiglottic space, and paraglottic spaces can act as tumor margins. At least one of the superior laryngeal neurovascular pedicles is preserved in the paraglottic space in order to ensure sensation of the supraglottic larynx. Closure proceeds with suspension of the hyoid bone and partial laryngeal closure if more than ½ of the tongue base was resected. A tracheostomy is required.

The **subhyoid supraglottic laryngotomy** is used to treat tongue-base cancers that invade the vallecula and come too close to the hyoid bone to allow its preservation. The lesion can involve the faucial arches but should not involve both lingual arteries or the mandible to be eligible for this procedure. A pull-through procedure can be combined for improved exposure.

The dissection is similar to the subhyoid pharyngotomy except that once the infrahyoid musculature is dissected from the hyoid the thyrohyoid ligament is identified. The superior laryngeal pedicle is identified in the paraglottic compartment. Anterior to this is a thin ligament which, when bluntly dissected, provides a plane between the paraglottic and preepiglottic compartments. When followed, this plane leads to the lateral edge of the epiglottis. The laryngotomy is performed at this level in such a way as to preserve at least one superior laryngeal pedicles. This structure can then provide sensation to the neolarynx. The suprahyoid muscles should be sutured to the anterior aspect of the thyroid lamina. A tracheostomy should be performed and partial closure of the larynx undertaken when more than 50% of the tongue base has been resected.

A **transthyroid supraglottic laryngotomy** is indicated for tongue-base lesions that is deeply invading the supraglottic larynx without evidence of impaired vocal cord movement or extension into the lower paraglottic space. This approach can be combined with a pull-through procedure, but should not be performed when bilateral lingual arteries or the mandible is involved with tumor.

The procedure is similar to a supraglottic laryngectomy with a transthyroid cartilage laryngotomy for complete removal of the upper paraglottic spaces and the preepiglottic space in continuity with the tongue base. Once removed, the suprahyoid musculature is sutured to the remaining thyroid cartilage. Mucosal closure often requires a flap, and partial closure of the larynx with a permanent tracheostomy is often necessary.

Finally, a **total laryngectomy with tongue-base resection** can be used to address tongue-base cancer than is deeply invading the larynx, but does not involve both lingual arteries or the mandible. Total laryngectomy with tongue-base resection should also be considered for those patients with smaller lesions, but poor pulmonary reserve (as the majority of the above procedures result in chronic aspiration).

The procedure is carried out in a standard fashion for total laryngectomy except that the pharyngotomy is made either through an uninvolved piriform sinus or via a transtracheal, post-cricoid approach. Primary closure may be possible, but often requires a myocutaneous flap for larger defects.

## Related Topics

### Other approaches to the oropharynx

Authors have described other approaches to the oropharynx which are rarely used. These include maxillectomy for high lesions, and infratemporal fossa approach for lesions of the superior and lateral oropharynx.

### Mandibulotomy

Mandibulotomy is the division of the mandible in order to afford exposure to more posterior and medial structures by “swinging” the posterior segment laterally. Once the surgical goal has been accomplished, the mandibular segments are reapproximated using either plates or wire. There are essentially two types of mandibulotomy. They are divided by their relation to the mental foramen. Those anterior to the foramen are considered “midline” mandibulotomies, and those posterior to this structure are considered “lateral.” Performing a lateral mandibulotomy requires division of the mental artery and nerve. This severely compromises blood flow to the bone anterior to the cut. When combined with the effects of radiation therapy this approach can lead to nonunion or osteoradionecrosis. Today, midline mandibulotomy is used unless mandibulectomy is planned. Midline approaches can be further subdivided as true midline and paramidline osteotomies. The true midline mandibulotomy is made between the two mandibular central incisors. It requires division of the genioglossus, geniohyoid and mylohyoid muscles on one side. Many authors describe removing one of the incisors in order to provide room enough to avoid injury to both anterior incisors and the risk of necessitating subsequent dental intervention during radiation therapy. Others report that midline osteotomy is possible without injury to either incisor when a thin saw blade is used. Paramidline incisions are made between the mandibular lateral incisor and the canine. The angle between the roots of these teeth is more than two times as large as that between the central incisors. This obviates the need for removing a tooth for the osteotomy. The paramidline (paramedian) osteotomy also preserves the attachments of the genioglossus and geniohyoid muscles. Vascular supply to the bone anterior to the cut is supplied by anastomoses from the contralateral inferior alveolar vessels and periosteum. There has been concern over the viability of this blood supply, especially in patients undergoing radiation therapy. Paramedian osteotomies may lie within the radiation field (not often a problem with a midline cut). This has led to concern for healing delay and other postoperative morbidity, though results of studies of radiation effects on osteotomy healing have been inconclusive.

Whatever the approach, it is thought best to avoid extensive elevation of the periosteum in order to maintain periosteal circulation and decrease venous stasis. Osteotomies can be notched or stair-stepped to provide more stability during reconstruction. It is important to avoid tooth roots when performing these cuts. One study looked at the length of incisor and canine mandibular teeth and proposed that paramedian vertical osteotomies be at least 15 mm in length before the vertical cut is made. (Pan) A simple vertical osteotomy has been shown to be just as effective and safe when combined with rigid plate fixation. Postoperative complications with midline mandibulotomy has historically hovered around 20%, though one study of true midline osteotomies using a thin blade reconstructed with one inferiorly-based 2.3mm plate showed a 0% morbidity rate (nonunion, malunion, plate exposure, tooth loss, site pain). Riddle, et al., on the

other hand, report that the majority of patients who undergo mandibulotomy should expect to have minor sequelae (abnormal sensation, changed occlusion, TMJ pain.) A recent study showed no statistical difference in complication rates between true midline and paramidline mandibular osteotomies performed on patients with cancer of the oral cavity or oropharynx.

### **Marginal mandibulectomy**

When tumor is noted to be abutting, but not invading the mandibular cortex a marginal mandibulectomy may be performed. This essentially removes the medial cortex of the mandible as a tumor margin in continuity with the tumor specimen. This procedure does not require special plating, but does require tooth extraction if the patient has teeth in the involved segment. If the bone has been eroded or invaded by tumor a segmental mandibulectomy is indicated.

### **Tracheostomy**

Tracheostomy is indicated for procedures that may result in airway obstruction, or when post-operative aspiration may be a problem. Thus, any patient that undergoes a procedure that involves resection of greater than 50% the tongue base, or includes reconstruction with bulky flaps should have a tracheostomy. Patients undergoing procedures that are likely to result in tongue-base edema should also be considered for tracheostomy. Any procedure that includes a low lateral pharyngotomy or laryngotomy should include a tracheostomy. Tracheostomy is not usually indicated with transoral procedures except with a median labio-mandibulo glossotomy. Finally, an plans for an oropharyngeal bolster should prompt a proposal for tracheostomy.

### **Conclusion**

The oropharynx is an anatomical structure surrounded by bony structures, vital arteries, and important nervous structures. As a result, there is no one approach that allows wide exposure with only minimal morbidity. As a result, the surgeon is forced to choose which structures to damage or sacrifice in order to reach the oropharynx. This decision is best made after understanding the location and extent of the lesion in question. This knowledge, combined with understanding of the patient's medical status and personal wishes guides the selection of the surgical approach. Minimizing morbidity while ensuring good oncologic tissue margins is difficult in this area of the human anatomy. Only a head and neck surgeon who understands the relevant anatomy and the surgical options is likely to fully realize these goals.

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