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## **Introduction**

The oropharynx is comprised of four distinct sites 1) soft palate, 2) palatine tonsil/tonsillar fossa, 3) posterior pharyngeal wall, and 4) the base of tongue. The oropharynx is anatomically contiguous with the oral cavity, nasopharynx and hypopharynx. It is a complex anatomical and physiological site that is necessary for deglutination, speech, respiration, and immunological defense. These sites are prone to squamous cell carcinoma in individuals who have a history of extensive tobacco or alcohol use. Squamous cell cancer of the tongue base is one of the most challenging tumors to manage.

## **Anatomy**

### **Oropharyngeal embryology**

The oropharynx is derived from endoderm. Until the end of the third week, the endodermally derived oropharynx is separated from the ectodermally derived nasal cavities by the buccopharyngeal membrane. By the fourth week, the pharyngeal pouches, grooves, arches, and membranes develop. The epithelial lining of the anterior tongue is derived from the first pharyngeal arch. The third arch is responsible for the posterior tongue. The third and fourth arch help form the hypopharyngeal eminence, which gives rise to the epiglottis. The anterior tongue is innervated by the nerve of the first arch, trigeminal, while the posterior tongue is innervated by the third arch nerve, glossopharyngeal. The secondary palate becomes recognizable in the ninth week, after the fusion of the maxillary processes. It is separated from the primary palate by the incisive foramen, and forms the posterior hard palate and the soft palate. The tonsillar fossa, palatine tonsils, and lingual tonsils form from the endoderm of the second pharyngeal pouch.

## Surgical anatomy

The superior limit of the oropharynx is the superior surface of the soft palate, and the inferior limit is the superior surface of the hyoid bone. The anterior border is the soft palate and uvula, palatoglossal arch, and the V-shape circumvillate papillae of the tongue base. The valleculae are the transition point from the tongue base to the epiglottis. They are paired grooves that are bounded by the lateral glossoepiglottic folds laterally, and separated in the midline by the median glossoepiglottic fold. The posteriorly and lateral boundaries are the pharyngeal walls. **Waldeyer's ring**, an area of lymphoid tissue, includes the palatine tonsils, adenoid pad, and lingual tonsil, which surround the oropharyngeal opening.

The **soft palate** separates the nasal cavity from the remaining aerodigestive tract during swallowing and speech. The junction of the hard and soft palate marks the end of the oral cavity, and the beginning of the oropharynx. The palatine aponeurosis is integral in the function of the soft palate. The aponeurosis is an extension of the periosteum of the hard palate, and the tensor veli palatini and levator veli palatini insert onto it. The tensor veli palatini is innervated by the mandibular nerve (CN V), and is responsible for elevating the soft palate, as well as, opening the eustachian tube. The levator veli palatini is innervated by the pharyngeal plexus (CN IX and X). The uvula is the midline structure that touches the base of tongue at rest.

The **tonsillar fossa and palatine tonsils** are paired structures that comprise the majority of the lateral pharyngeal wall. The tonsillar fossa is bound anteriorly by the palatoglossal arch and posteriorly by the palatopharyngeal arch. The blood supply to the palatine tonsils include the tonsillar branch of the facial artery, ascending pharyngeal, the dorsal lingual, the descending palatine and branches from the internal maxillary arteries. Posterior to the tonsillar fossa is the superior pharyngeal constrictor, and the upper fibers of the middle constrictor. Posterolateral to the tonsillar fossa is the internal carotid, within the parapharyngeal space.

The **posterior pharyngeal wall** begins at the soft palate and extends down to the base of the epiglottis. The second vertebra is often palpated at the midline of the posterior pharynx. The posterior pharyngeal wall is a layered structure consisting of mucosa, submucosa, pharyngeal constrictor, pharyngobasilar fascia, and prevertebral fascia. The retropharyngeal space is a potential space between the pharyngobasilar fascia and the prevertebral fascia. The pharyngobasilar fascia acts as a natural barrier to tumor spread, once this fascia is violated, the tumor has a direct pathway to the vertebra and becomes unresectable.

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, the septum linguae, can be used for surgical access to the base of tongue. Blood supply to the tongue arises from the lingual arteries, which enter the

tongue base medial to the hyoglossus muscle. An important branch from this artery is the sublingual arteries, as they form an anastomotic network which can supply blood to the contralateral half of the tongue. The hypoglossal nerve runs superficial to the facial and lingual arteries, and lateral to the hypoglossus muscle and genioglossus muscles. Tongue deviation, fasciculations, and tongue atrophy are signs of advanced tumor growth. 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 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 to the 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 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 retraction 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. In advanced tongue base cancers, this tumor extends beyond this ligament into the pre-epiglottic space and into the laryngeal framework.

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.

## **Incidence and Etiology**

Oropharyngeal carcinoma occurs at a rate of 11.9/100,000 population annually with approximately 30,000 new cases per year. This is the fastest growing segment of Head and Neck cancer. There is a 3:1 male predominance, and among men African Americans have the highest rates, followed by whites, Vietnamese, and then native Hawaiians. Tongue base tumors account for approximately half of all oropharyngeal tumors.

Etiologic factors include the same risk factors found for most upper aerodigestive tract carcinomas. Alcohol and tobacco each alone increase the risk of developing oropharyngeal carcinoma 1.2-9.0 times. When combined, the risk is not additive, but exponential.

## Tongue base tumors

These tumors are among the most difficult to treat. These patients usually present at an advanced stage because these neoplasms may remain asymptomatic and hidden for many months. There is a male predominance, 70% are men, and they usually present in the sixth decade. Sore throat occurs in approximately 60%, and other symptoms include otalgia, dysphagia, "hot potato voice," weight loss, or neck mass. More than 60% of these patients have at least one clinically positive node at presentation. Level II and III nodes are the predominant nodes, and there may be bilateral or contralateral nodal involvement at initial presentation. Five year survival is 40-60%, with nodal involvement this survival drops by half. Treatment of these tumors requires a multidisciplinary team consisting of oncologic surgeon, medical and radiation oncology, pathologists, and speech and swallowing specialists.

## Surgical Resection

There are many approaches to resecting oropharyngeal masses. Some are simple, but many are complex due to the fact that some of the posterior and inferior oropharynx are hidden and difficult to expose adequately. Also, the close proximity of the mandible, vascular structures, nerves, parapharyngeal space, and narrow introitus make resection challenging. Surgical approaches attempt to gain wide exposure of the tumor and surrounding structures to obtain adequate tumor margins, and safely remove the tumor without damaging adjacent structures. Often, a neck dissection precedes the surgical approach to aid in identifying and protecting vital cranial nerves, and vascular structures.

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 excision** can be used in select, small tumors of the base of tongue. The use of cold steel or laser may be used to obtain tumor free margins.

**Anterior midline labiomandibuloglossotomy** (Trotter's procedure) can be used for tumors limited to the tongue base. It requires a lip splitting incision, median mandibulotomy, and bisecting the tongue through the septum linguae to reach the tongue base.

The **mandibular swing procedure** usually provides the best exposure for tongue base tumors. The lip is split similar to the Trotter's procedure, but a lateral or paramedian mandibulotomy is performed. The mucosa and muscles of the floor of mouth are incised posteriorly up to the anterior tonsillar pillar. The lingual nerve and styloglossus muscle are encountered and transected to allow the mandible to swing laterally. This affords wide exposure to the oropharynx. If the tumor also invades the mandible, then mandibulectomy and soft tissue will need to be resected en bloc (commando procedure).

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. **Anterior pharyngotomy** may also be used for selected, small tongue base tumors. The **transhyoid approach** requires transecting or removing the hyoid bone to gain access to the oropharynx, while the **suprahyoid approach** reflects the hyoid inferiorly to gain access to the oropharynx. The main drawbacks of this procedure are limited access, and the valleculae are entered blindly. Deeply invasive tongue base tumors may breach the hypoglottic ligament and extend into the laryngeal framework. These tumors may require a **supraglottic or total laryngectomy** in addition to tongue base resection.

## **Reconstruction of defects**

The tongue base presents a challenge to the reconstructive surgeon because of its proximity to the larynx, and the risk of aspiration after its removal. Also, some cancers extend in to the anterior tongue and total glossectomy may need to be performed. The goals of tongue base reconstruction are 1) maintenance of the airway, 2) swallowing, and 3) articulation. The tongue base is integral in swallowing and respiration, but if a significant portion of the anterior tongue is removed during resection, then articulation becomes a problem as well. The ideal reconstruction provides protection from aspiration, dynamic capability for swallowing and speech, and a sensate tissue for more physiologic swallow.

### **Reconstructive ladder**

The reconstructive ladder for the base of tongue begins with healing by secondary intention, primary closure, skin grafting, regional flaps, and microvascular free flaps. Small defects are those which are less than 30% of the tongue base volume, these can be closed by secondary intention, primary closure or skin grafting with little functional deficit. Defects larger than 30% must be closed by either a pedicled flap or free flap because primary closure or secondary intention lead to tongue tethering and functional deficits.

### ***Regional flaps***

The advantages of these flaps include single-stage reconstruction, well vascularized tissue, and relative ease of harvesting. Disadvantages are tip necrosis, limited superior reach, and bulky tissue. The pectoralis major flap is the workhorse flap, others include the sternocleidomastoid flap, latissimus dorsi, trapezius, and platysmal flaps. These flaps result in poorer function due to bulkiness, and insensate nature of the flap.

### ***Microvascular flap***

These flaps overcome many of the pitfalls of the regional flaps and have the ability to provide sensory and motor innervations. These flaps are technically more difficult to harvest and require a microvascular surgeon. The radial forearm flap is the workhorse, others include the lateral arm, lateral thigh, rectus abdominis, and latissimus dorsi. These flaps require diligence on the part of the surgeon, anesthesiologist, and perioperative nurses before, during, and after the microvascular anastomosis and inset. These flaps can offer great functional outcomes due to their ability to provide sensory as well as motor function.

### **Conclusion**

The oropharynx is a complex anatomical region with limited access. Treating cancers in this region require a multidisciplinary team equipped with an oncologic surgeon, reconstructive surgeon, speech therapist, medical oncologist, radiation oncologist, oral surgeon, and dedicated nursing staff. The decision for surgical resection rests on size and stage of the cancer. Most of these cancers will be treated with a combination of radiation and chemotherapy, but for those select few, primary resection followed by post-operative radiation will give the patient equal survival chances. These patients will need reconstruction of their defect, and the most important determining factor should come down to quality of life for the patient. The method of reconstruction chosen must give the patient the best chance of reestablishing an oral diet and a stable airway without cannulation. This can be achieved by following the reconstructive ladder, and knowing the ones limitations as reconstructive surgeon.

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