Imaging of primary lesions of the root of the tongue

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Learning objectives

The current exhibit aims:

- To review the normal tongue anatomy
- To discuss the imaging features of a variety of the primary lesions of the tongue

Background

The root of the tongue is an important subregion of the oral cavity, associated with very specific differential diagnoses. It is relatively resistant to primary neoplastic and infectious processes due to its high percentage of skeletal muscle and lack of significant lymphatic tissue.

Assessing and understanding the tongue morphology is valuable for proper surgical planning, which may considerably reduce post-operative complications and lead to a faster rehabilitation (1). The majority of lesions found in the root of the tongue are congenital and benign, representing ectopic tissues of thyroidal, epidermal, dermal, foregut, venous, and lymphatic origin. In children, these lesions are more frequently evaluated with MR imaging. In adults, the assessment of masses of the oral cavity and suprahyoid neck is often begun with CT. MR imaging is reserved for evaluating the extent of involvement in larger lesions. Cross-sectional imaging plays an important role due to complex anatomy of the oral cavity and delineates the exact location of the tumor. Some specific lesion characteristics can help tailor the differential diagnosis.

The normal tongue anatomy:

The tongue is basically a mass of muscle that is almost completely covered by a mucous membrane. It occupies most of the oral cavity and oropharynx. It is known for its role in taste, but it also assists with mastication (chewing), deglutition (swallowing), articulation (speech), and oral cleaning. Five cranial nerves contribute to the complex innervation of this multifunctional organ. The median sulcus of the tongue separates the body into left and right halves. The terminal sulcus, or groove, is a V-shaped furrow that separates the body from the base of the tongue (fig.1). At the tip of this sulcus is the foramen cecum, a remnant of the proximal thyroglossal duct. The base of tongue contains the lingual tonsils (fig.2), the inferiormost portion of Waldeyer's ring.
The tongue has 4 intrinsic and 4 extrinsic muscles (Table 1) (2). The muscles on each side of the tongue are separated by a fibrous lingual septum. Extrinsic muscles (fig.3, fig.4) are so named because they originate outside the tongue and insert within it; intrinsic muscles are within the substance of the organ and do not insert on bone. Although the muscles do not act in isolation, intrinsic muscles generally alter the shape of the tongue, whereas extrinsic muscles alter its position.

Table 1: muscles of the tongue

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Type</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior longitudinal</td>
<td>Intrinsic</td>
<td>Lingual septum and submucous fibrous layer</td>
<td>Margins of tongue</td>
<td>Raises tip and sides of tongue; shortens tongue</td>
</tr>
<tr>
<td>Inferior longitudinal</td>
<td>Intrinsic</td>
<td>Body of hyoid and base of tongue</td>
<td>Apex of tongue</td>
<td>Curls tip inferiorly; shortens tongue</td>
</tr>
<tr>
<td>Transverse</td>
<td>Intrinsic</td>
<td>Lingual septum</td>
<td>Submucous fibrous layer</td>
<td>Narrows and lengthens tongue</td>
</tr>
<tr>
<td>Vertical</td>
<td>Intrinsic</td>
<td>Superior surface of tongue</td>
<td>Inferior surface of tongue</td>
<td>Flattens and broadens tongue</td>
</tr>
<tr>
<td>Genioglossus</td>
<td>Extrinsic</td>
<td>Mental spine of mandible</td>
<td>Lateral and inferior tongue</td>
<td>Depresses and retracts tongue</td>
</tr>
<tr>
<td>Hyoglossus</td>
<td>Extrinsic</td>
<td>Body and greater horn of hyoid</td>
<td>Lateral and inferior tongue</td>
<td>Depresses and retracts tongue</td>
</tr>
<tr>
<td>Styloglossus</td>
<td>Extrinsic</td>
<td>Styloid and stylohyoid ligament</td>
<td>Lateral and inferior tongue</td>
<td>Retracts tongue</td>
</tr>
<tr>
<td>Palatoglossus</td>
<td>Extrinsic</td>
<td>Palatine aponeurosis</td>
<td>Lateral tongue</td>
<td>Elevates posterior tongue</td>
</tr>
</tbody>
</table>

The tongue is often divided into the mobile tongue and the base of the tongue. The mobile tongue extends from the frenulum to the circumvallate papillae and is part of the oral cavity. The base of the tongue is posterior to the circumvallate papillae and is part of the oropharynx. However, head and neck subspecialists often refer to the region deep to the mobile tongue and anterior to the base of the tongue as the root of the tongue. The root of the tongue includes the lingual septum and bilateral genioglossus and geniohyoid muscles (genioglossus-geniohyoid complex). Both muscle groups originate from the symphysis menti on the back of the mandible. The borders of the root of the tongue are well defined anteriorly, laterally, and inferiorly. The anterior border is defined by the mandible and is easily seen at MR imaging and computed tomography (CT). Laterally, the sublingual spaces can be distinguished from the root of the tongue at MR imaging on the basis of their higher T1 and T2 signal from higher fat and connective tissue content. The inferior border is well defined by the U-shaped mylohyoid muscle under the geniohyoid muscles. Posteriorly, the root of the tongue must be differentiated from the base of the tongue. The root of the tongue includes the visible tongue musculature, whereas the base of the tongue encompasses the posterior lymphatic tissue. The superior border of the root of the tongue is the most indistinct, since the genioglossus muscle fans out and blends
into the intrinsic tongue muscles within the mobile tongue. The border is difficult to define radiologically; at clinical examination, however, a mass will be seen to cause greater tongue fixation during tongue protrusion the more it involves the root of the tongue (3).

**Vasculature:** the tongue derives its arterial blood supply from the external carotid artery. The lingual artery branches off the external carotid artery deep to the stylohyoid muscle. At first it travels superomedially, but after a short distance it changes direction and moves anteroinferiorly. The hypoglossal nerve (cranial nerve XII) crosses over it laterally before it enters the tongue deep to the hyoglossus muscle. Within the tongue, the lingual artery gives rise to its 3 main branches: the dorsal lingual, deep lingual, and sublingual arteries. The dorsal lingual artery supplies the base of the tongue. The deep lingual artery travels on the lower surface of the tongue to the tip. A branch to the sublingual gland and the floor of the mouth is known as the sublingual artery (fig.5).

The veins of the tongue parallel the lingual artery branches. The deep lingual vein begins at the tip of the tongue and travels posteriorly to join the sublingual vein. This drains into the dorsal lingual vein, which accompanies the lingual artery. Directly or indirectly, this vein empties into the internal jugular vein.

**Nerve supply:** Motor innervation for all of the muscles of the tongue comes from the hypoglossal nerve—with the exception of the palatoglossus, which is supplied by the pharyngeal plexus (fibers from the cranial root of the spinal accessory nerve carried by the vagus nerve). General sensation (fig.2) of the anterior two thirds of the tongue is supplied by the lingual nerve, a terminal branch of the third division of the trigeminal nerve (V3). Taste sensation for this portion of the tongue is carried by the chorda tympani branch of the facial nerve. The posterior one third of the tongue relays general and sensation via the lingual-tonsillar branch of the glossopharyngeal nerve. Some general and taste sensation from the base of tongue anterior to the epiglottis is carried by the internal laryngeal branch of the superior laryngeal nerve (CN X).

**Lymphatic drainage:** The lymphatic drainage of the tongue is complex. Lymphatics from the tip of the tongue travel to the submental lymph nodes. This can be ipsilateral or bilateral depending on the site of the lesion. Lymph from the medial anterior two thirds of the tongue travels to the deep cervical lymph nodes, and lymph from the lateral anterior tongue goes to the submandibular nodes. The tongue-base lymphatics drain bilaterally into the deep cervical lymph nodes.

Images for this section:
Fig. 1: Diagrams showing the parts of the tongue

Fig. 2: Dorsum of the tongue, showing the anatomical structures of the tongue and sensory innervation on one side. The numbers refer to cranial nerves.
**Fig. 3:** Axial drawing (left) and T1-weighted magnetic resonance (MR) image (right) demonstrate the root of the tongue. The high-signal-intensity lingual septum (ls) is clearly seen and is flanked by the genio-glossus muscles (gg), which form an inverted V anteriorly before blending into the intrinsic muscles of the mobile tongue. The sublingual spaces (sls) are lateral to the genioglossus and geniohyoid muscles and also show high T1 signal intensity.

**Fig. 4:** On a coronal drawing (left) and T1-weighted MR image (right), the genioglossus muscles (gg) resemble paramidline vertical pillars. Below the genioglossus muscles, the geniohyoid muscles (gh) appear subtly wider than they do on axial images (cf Fig 1). The sublingual spaces (sls) show high T1 signal intensity. ls = lingual septum.
Fig. 5: Diagrams showing the lingual artery
Findings and procedure details

Diagnostic imaging modalities of lesions in the oral region include computed tomography (CT), ultrasound and MRI. Magnetic resonance imaging (MRI) has become increasingly important as a means of investigating the structure and function of the human tongue. The standardize protocol for evaluating lesions, which consists of plain T1-spin echo (SE), plain fat-suppressed (FS) T2 turbo-spin echo (TSE), and FS-T1-TSE after Gd-DTPA. For diagnosis of oral lesions, it is essential to clarify the normal anatomical structures of the tongue on MRI, using conventional T1WI and T2WI, as well as fat-suppressed enhanced scans. Sigal et al. (1996) pointed out that 2 different groups of muscles were discriminated in this area by T1WI, based on their differing fat content: the low signal area (LSA) and the high signal area (HSA). This result suggests that, when diagnosing the mass lesion in the tongue, T1WI is needed to understand the anatomical structure and fat-suppressed enhanced scan is needed to good contrast between the tumor and the normal portion of the tongue. In both types of sequences, the intrinsic tongue musculature could not be identified. The anterior part of the tongue has more possibility of movement during the examination, and it tends to affect susceptibility artifact that induced from dental prostheses, these induced the imperfect fat suppression of the anterior thin portion (4).

1. Imaging Features of Lesions

Lesions involving the root of the tongue can be classified into congenital vascular and nonvascular lesions, infections, and neoplasms. Congenital vascular and nonvascular lesions make up the largest group of lesions.

1.1 Congenital Nonvascular Lesions :

a) Lingual Thyroid :

Lingual thyroid is a specific type of ectopic thyroid, and results from lack of normal caudal migration of the thyroid gland. Thyroid tissue may be found anywhere along the course of the thyroglossal duct, however complete arrest with thyroid tissue located at the base of tongue is most common, and represents 90% of all cases of ectopic thyroid. CT demonstrates are hyperdense soft tissue mass, of the same attenuation as normal thyroid tissue. It is hyperdense on account of the accumulation of iodine within the gland. Following contrast administration, the entire gland demonstrates prominent homogenous enhancement. MRI usually seen as a well defined mass with no invasive features signal characteristics include, in T1 iso to hyperintense signal to muscle, in T2 can vary from hypo to iso to hyperintense to muscle, in T1 + (Gd) demonstrate homogeneous contrast enhancement (5). A thyroid scan is excellent at not only confirming the diagnosis, but also identifying the presence of any thyroid tissue elsewhere in the neck.
b) **Thyroglossal Duct Cyst (TDC):**

TDC is the most common nonodontogenic cyst in the neck, representing approximately 70% of all congenital neck abnormalities. It is a cystic remnant along the course of the thyroglossal duct between the foramen cecum of the tongue base and the thyroid bed in the visceral space of the infrahyoid neck. The 2 most common complications of TDC are infection and malignancy. Ultrasonography (fig. 6) is the preferred imaging technique in children is used to confirm the clinical diagnosis and identify the presence of the thyroid gland. CT and MRI are useful for determining the full extent of the lesion and its sometimes complex relationship to surrounding structures such as the hyoid bone. The attenuation of thyroglossal duct cysts is usually between 0 and 20 HU at CT. The signal at MR imaging is high T2 and intermediate T1. The fluid within the lesion can be proteinaceous or hemorrhagic, making the lesion higher in attenuation and higher in T1 signal (3).

c) **Dermoid and Epidermoid Cysts**

Epidermoid and dermoid cysts represent less than 0.01% of all oral cavity cysts. The cysts can be defined as epidermoid when the lining presents only epithelium, dermoid cysts when skin adnexa are found, and teratoid cysts when other tissue such as muscle, cartilage, and bone are present (6). Depending on the size of the lesion, it can displace the tongue and cause dysphagia, dysphonia, and dyspnea (7). It can be difficult to distinguish between dermoid and epidermoid cysts at imaging. Both types of lesions are well circumscribed and have high T2 signal with no enhancement or only rim enhancement. At imaging, the additional complexity of dermoid cysts is sometimes reflected by greater signal heterogeneity. Epidermoid cysts usually lack observable solid components. In dermoid cysts, intralesional fat is a distinguishing feature and is nearly pathognomonic. Epidermoid cysts may show restriction (high diffusion and a low apparent diffusion coefficient) at diffusion imaging, which is a characteristic feature.

d) **Lipoma:**

Lipomas represents only 0.1%-5% of benign lesions in the oral cavity. Ultrasonography shows a round or elliptical in shape lesion, with intact capsule, most of lipomas are hypo-echoic with echogenic lines or spots. Lipomas are usually easily identified, at CT, nonenhancing fat density mass (-65 to -125HU), homogeneous without any internal soft tissue stranding, At MR imaging, lipomas have T1 and T2 signal higher and the signal suppressed at fat-suppressed contrast image.

e) **Haemangioma of the tongue:**
Haemangiomas are one of the most common benign tumors. Hemangiomas of the oral cavity are uncommon but have a predilection for the tongue. At CT, lingual hemangiomas enhance intensely and often have prominent lesional and perilesional vasculature. At MR imaging, lingual hemangiomas have a T2 signal higher than that of muscle and also show intense enhancement. The prominent vasculature may be seen as flow voids at MR imaging (3).

2. Infection:

Tongue abscess is a rare and sometimes life-threatening condition. At CT, mature infections (eg, abscess) manifest as thick-rim enhancing fluid-attenuation lesions, whereas immature infections (eg, phlegmon) manifest as ill-defined regions of heterogeneous enhancement. At MR imaging, tongue abscesses manifest as thick-rim enhancing lesions with high T2 signal, whereas phlegmon is ill defined with high T2 signal and mixed enhancement. Prominent localized swelling is often seen (3).

3. Malignant Neoplasms:

MRI is the preferred modality in the evaluation of tongue carcinomas. Tumour invasion of the floor of the mouth is particularly well seen on coronal images. Sagittal images provide information on tongue base involvement and the extent of pharyngeal infiltration that cannot be seen on CT. However, cortical bone involvement, notably the mandible is diagnosed with a higher level of certainly on CT. Tumours in the anterior third of the oral tongue invade the floor of the mouth. Middle-third lesions infiltrate the musculature of the tongue and later, the lateral floor of the mouth (fig. 7-9). Carcinomas involving the posterior third of the oral tongue grow into the musculature of the tongue, the floor of the mouth, the anterior tonsillar pillar, the tongue base, the glossotonsillar sulcus and the mandible.

The tongue base carcinoma is a clinically silent region and tumours tend to spread with deep infiltration. Tongue base tumours tend to remain in the tongue except for laterally placed lesions or late cases. Under such circumstances, tongue base tumours may extend into the tonsillar fossa. Tonsillar carcinomas, on the other hand, have a tendency to invade the tongue base. Vallecular lesions are relatively exophytic and spread along the mucosa to the lingual surface of the epiglottis, laterally along the pharyngoepiglottic fold and then to the lateral pharyngeal wall and anterior wall of the pyriform sinus. Anterior infiltration involving the floor of the mouth and sublingual space, as well as invasion of the pre-epiglottic space is best evaluated with imaging (8).

Images for this section:
Fig. 6: Thyroglossal duct cyst on ultrasonography: very limited mass with anechoic content extending into the submandibular space.
Fig. 7: Squamous cell carcinoma of the tongue. Sagittal (a) and coronal T2(b) weighted images show infiltrative mass of the right half of the tongue with extension at the base of the tongue; axial contrast-enhanced T1 (c) weighted images show the enhancement of the tumor.

Fig. 8: Squamous cell carcinoma of the root of the tongue: coronal T1 (a) and T2 (b) weighted images show tumor of the root of the tongue infiltrating the left sublingual space. Contrast-enhanced coronal T1 weighted image(c) shows heterogeneous enhancement of the tumor.
Fig. 9: Axial (a) and coronal (b) post-contrast CT images show a large right-side tongue carcinoma with infiltration (long arrow) of the tongue musculature (genioglossus).
Conclusion

CT and MRI are complementary in the assessment tongue pathology. CT is readily accessible and offers faster image acquisition; therefore, it usually serves as a first-line investigation to broadly distinguish pathological processes. CT provides a better assessment of cortical bone involvement [5, 6], and MRI has the advantage of better characterising local tumour extent, bone marrow involvement and detection of perineural spread.

Personal information

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