

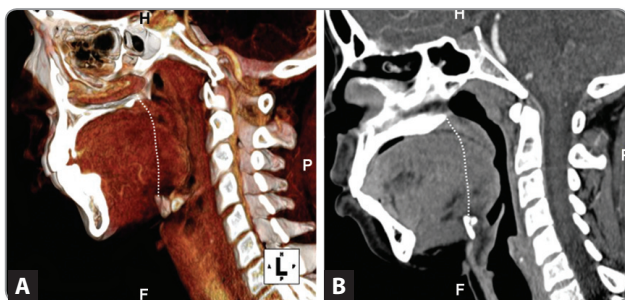
Radiographic anatomy and pathology of the oral cavity

chapter 7

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Introduction

The oral cavity is the most anterior portion of the head and neck containing a wide variety of tissues in a relatively small region. The first important distinction is separating the oral cavity from the oropharynx. The posterior oral cavity is delineated from the oropharynx by an imaginary line along the circumvallate papillae, anterior tonsillar pillars, and junction of the hard and soft palate (**Figure 7.1**). This distinction is clinically relevant because carcinomas in the oral cavity and oropharynx are different in both presentation and prognosis. The remaining boundaries of the oral cavity include: the lips anteriorly; the cheeks laterally; the hard palate superiorly, superior and inferior alveolar ridges, and the mylohyoid muscle inferiorly. Contained within these margins are the lips and their vermilion border, the anterior

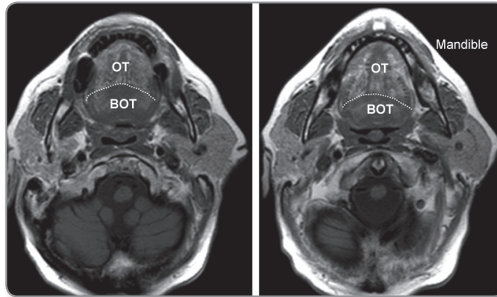


Figures 7.1A and B Sagittal CT of the normal oral cavity anatomy in 3D reconstruction (A) and sagittal plane. The dotted line shows the posterior margin of the oral cavity. It marks the posterior margin of the hard palate and the circumvallate papillae. The oral tongue is anterior to the line and the tongue base is posterior.

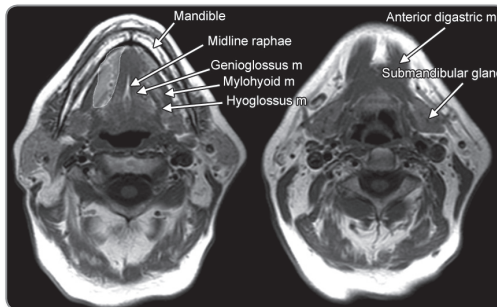
2 Techniques in head and neck imaging

two thirds of the oral tongue, floor of mouth, buccal mucosa, upper and lower gingiva, hard palate, anterior tonsillar pillar and retromolar trigone. Tumors and various pathologies can arise from any of the tissues within the oral cavity including the gingival, lingual and buccal mucosal linings, bone, teeth, muscles, nerves, blood vessels, and salivary glands.

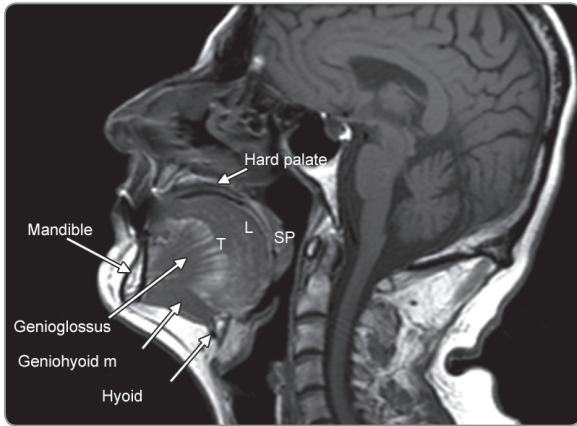
Cross sectional anatomy of the oral cavity



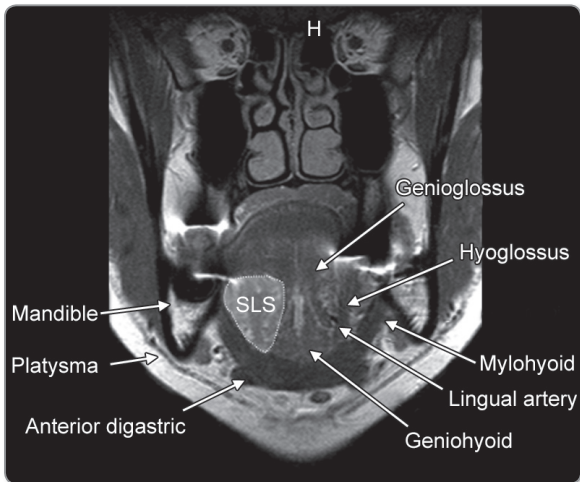
Axial T1 weighted MRI series through the oral cavity. Dotted line represents the circumvallate papillae separating the oral tongue (OT) and the base of tongue (BOT). Shaded area outlines the sublingual space.



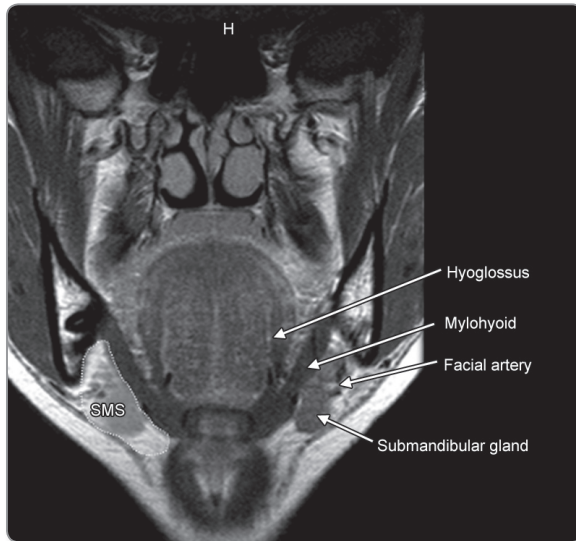
Axial T1 weighted MRI series through the oral cavity. Dotted line represents the Circumvallate papillae separating the oral tongue (OT) and the base of tongue (BOT). Shaded area outlines the sublingual space.



Sagittal T1 weighted image. Legend: SP – soft palate, L – longitudinal intrinsic muscle of tongue, T – transverse intrinsic muscle of tongue.



Coronal T1 weighted image of the oral cavity. Legend: Shaded area SLS – sublingual space, shaded area SMS – submandibular space



The lips and gingiva

The outer covering of the lips is composed of stratified squamous epithelium. This differs from inner surface which is lined by non-keratinizing stratified squamous mucosa. The space between the mouth and cheeks is the vestibule, which is lined by buccal mucosa arising from the teeth and gums. The parotid (Stensen's) duct curves along the buccal fat pad and drains into the vestibule opposite the second maxillary molar. The medial lingual mucosa and lateral buccal surfaces along the alveolar mandible and maxilla are called the gingiva. The junction point between the gingival and buccal mucosa is the gingivobuccal sulcus, which is an important potential site for oral cavity squamous cell carcinoma. The mucosa overlying the pterygomandibular raphe just posterior to the last mandibular molar is the retromolar trigone. The lips are innervated by motor divisions of CN VII. Lymphatic drainage is predominately to submental (level 1A) and submandibular (level 1B) lymph nodes.

The floor of mouth

The floor of mouth (FOM) is the U-shaped region of tissue that is situated along the anterior and sides of the tongue. The FOM is located between the surface mucosa and the mylohyoid muscle which forms the “floor” for the floor of mouth. The mylohyoid muscle **and** is best visualized in the coronal plane. The mylohyoid also divides the oral cavity into a superior sublingual space and inferior submandibular space. The mylohyoid muscle originates from the mylohyoid ridge or line along the inner mandible and extends posteriorly to the level of the posterior molar root. The posterior medial mylohyoid fibers insert on the hyoid bone and the posterior margin of the muscle is a free margin. The submandibular gland wraps around the free edge of the posterior mylohyoid and sits partially in the posterior sublingual space and the submandibular space. The mylohyoid muscle is innervated by the motor mylohyoid branch of the trigeminal nerve (CN V3).



The oral tongue

The mobile oral tongue has a dividing fibrous lingual septum or midline raphe. The tongue is composed of intrinsic and extrinsic muscle fibers. The four interdigitating intrinsic muscles comprise the majority of the tongue. These muscles are the superior and inferior longitudinal, transverse and the oblique muscles. The extrinsic muscles originate from bony attachments external to the tongue with their distal fibers interdigitating into the intrinsic musculature. The extrinsic tongue muscles include the genioglossus, styloglossus, hyoglossus and palatoglossus muscles. Both intrinsic and extrinsic tongue muscles receive motor innervation from the hypoglossal nerve (CN XII), which is located between the mylohyoid and hyoglossus muscles in the oral cavity. In addition, the palatoglossus receives innervation from the pharyngeal plexus. The sensory axons of the anterior two thirds of the tongue converge to form the lingual nerve, which is a branch of the mandibular division (V3) of the trigeminal nerve (CN V). The chorda tympani nerve is a division of the facial nerve (CN VII) and extends through the petrotympanic fissure and joins with the lingual nerve. These two nerve bundles then travel distally along the lateral border of the oral cavity. The parasympathetic fibers of the CN VII synapse

in the submandibular ganglion, which is suspended from the lingual nerve adjacent to the hypoglossal nerve.

The genioglossus is the largest extrinsic muscle and is a paired muscle with fibers separated by the midline lingual fatty septum. The genioglossus originates from a tendon arising from the genial tubercle along the inner mandible.

The styloglossus muscle originates from the styloid process and stylomandibular ligament. The fibers extend between the internal and external carotid arteries and superior and inferior constrictor muscles along the lateral oral tongue and divide into two sets of fibers. The muscle's longitudinal fibers insert along the side of the tongue anterior to the hyoglossus muscle. The posterior styloglossus fibers interdigitate with the hyoglossus muscle. The palatoglossus muscle arises from the soft palate and inserts on the lateral tongue with distal fibers inserting into the styloglossus muscle. The palatoglossus muscle and surrounding mucosa create the anterior tonsillar pillar or palatoglossal arch, and is considered part of the oral cavity.

The hard palate

The hard palate is formed by the palatine process of the maxilla and horizontal plates of the palatine bones. The hard palate is bounded both anteriorly and laterally by the alveolar processes and gingiva. Within the hard palate just posterior to the incisor teeth is the incisive foramen allowing passage for the nasopalatine nerves and arteries. This nerve an important nerve which needs to be anesthetized during upper dental work. In the posterior hard palate just medial to the posterior third molar are the greater and lesser palatine foramen through which travels the greater and lesser palatine arteries and nerves (**Figure 7.2**). The greater palatine artery and nerve supplies the tissues of the hard palate while the lesser palatine artery and nerve supplies the soft palate.

Maxilla and mandible

The maxilla and mandible are affected by a diverse range of pathologic processes. Many developmental, metabolic, neoplastic, inflammatory, and traumatic lesions or disorders which affect the skeleton can

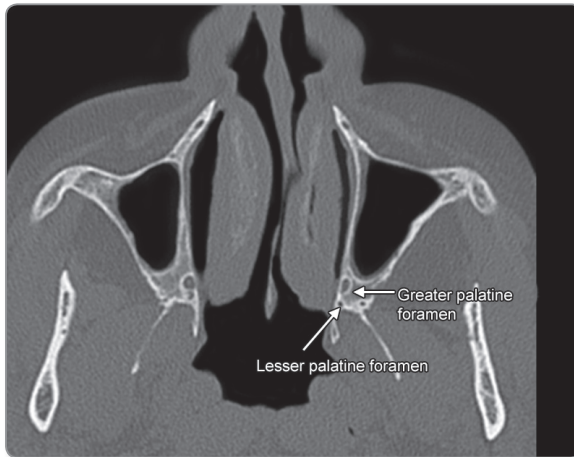


Figure 7.2 Axial CT image shows the greater and lesser palatine foramen.

present in the jaws. In addition, numerous benign and malignant soft tissue tumors as well as metastatic malignancies may present centrally within the maxilla or mandible. However, given the presence of teeth and associated structures, there are also a variety of pathologies which are unique to the jaws. Teeth can be a source of infection and inflammatory processes and can give rise to odontogenic cysts and tumors from tissues involved in tooth formation. The goal of imaging in this region is not only to determine the extent of disease, but also to characterize the radiographic features as an aid in generating a differential diagnosis and treatment planning. Assessment of lesion shape, borders, internal architecture, relationship and effects on surrounding teeth, expansion or perforation of cortical plates, and extension to soft tissue are fundamental to radiographic analysis.

Imaging of the oral cavity with CT and MRI

MRI and CT imaging of the oral cavity are complementary. CT offers excellent visualization of bony detail and lends itself well in the evalu-

ation of fracture and cortical erosion by tumor. MRI has advantages in its ability to resolve soft tissue anatomy. Both MRI and CT allow for multiplanar reconstruction. Protocols for MRI of the oral cavity carcinomas will defer from institution to institution. Ideally MRI should be performed with a dedicated neck coil. Imaging in the sagittal, axial and coronal planes are obtained generally with a slice thickness of 4 mm or less. At our institution, we perform sagittal and coronal imaging with fields of view on T1-weighted sequences in the axial plane ranging from 16-18 cm, and on T2-weighted sequences ranging from 18-20 cm. Pre and post-contrast T1-weighted images after intravenous administration of gadolinium should be performed in the same planes, allowing for differentiation of fat and proteinaceous fluids. A non-contrast T1 is used for delineating the anatomy and determining the status of the various normal fat and muscle planes. These imaging features are helpful when evaluating for tumor infiltration. Post-contrast T1 images with fat saturation are also useful in the assessment of perineural tumor spread. Having patients puff their cheeks during CT imaging can be performed. This would help in delineating masses within the buccal vestibule along the buccal or gingival surfaces. This technique is limited in MRI due to the greater time needed during image acquisition.

Pathology

Vascular

Vascular lesions of the oral cavity include any of the vascular lesions of the head and neck and can be classified either into two broad categories: hemangiomas or vascular malformations (VM). Hemangiomas are true neoplasms demonstrating actual cell proliferation. These present during infancy and will enlarge then involute as the patient matures. Vascular malformations are congenital lesions. They may manifest during infancy and childhood and will not regress. Vascular malformations can be subdivided into capillary, arterial, venous, lymphatic and mixed (**Figure 7.3**). A full discussion of these lesions is included in the chapter on Vascular Lesions of the Head and Neck.

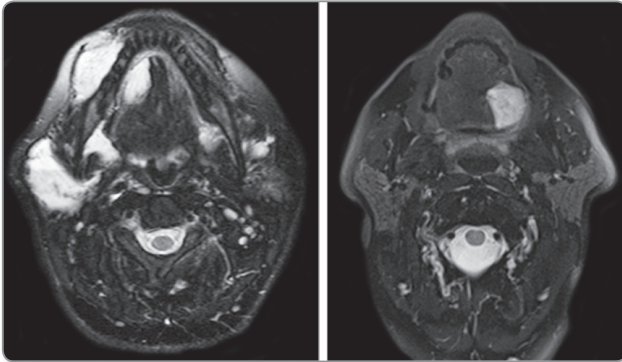


Figure 7.3 Venous vascular malformation (VVM) in two different patients. Left image shows an extensive lesion that involves the right sublingual space (SLS) as well as the right and left parotid, masticator space and the soft tissues over the right mandible. The right image shows a localized VVM involving the left posterior oral tongue. VVM are readily apparent as very high signal masses on these fat saturated T2 weighted images.

Infectious

Infection is the most common pathology seen in the oral cavity and may be secondary to poor oral hygiene, immuno-suppression, or from treatments such as radiation therapy that can alter the normal salivary pH resulting in an increased likelihood of dental disease. Imaging is critical for the assessment of the airway, the spaces involved, and detecting abscess formation. CT bone window images also allow for evaluation of periapical lucency around the teeth, suggestive of odontogenic disease. Ludwig's angina refers to a cellulitis of the FOM usually secondary to an infected mandibular molar. The bacterial agents are usually the oral flora. The tissues can undergo gangrenous necrosis with minimal pus. If untreated, FOM abscess can develop (**Figure 7.4**).

Neoplastic

In Western societies, oral cancer accounts for approximately 0.6% to 5.0 % of all cancers in societies such as the US, Europe and Australia. Oral cavity carcinoma is the sixth leading cause of cancer in the world.

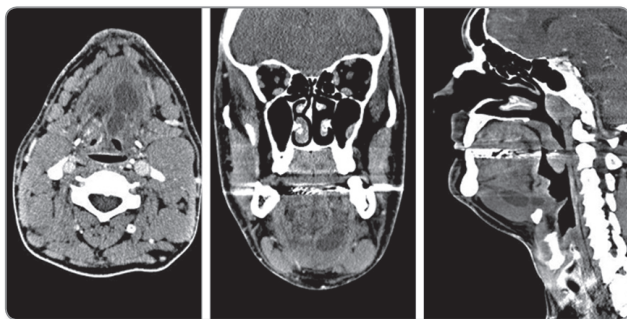


Figure 7.4 Floor of mouth abscess. Courtesy of Dr Eric Bartlett.

Risk factors include alcohol and tobacco (they are synergistic), sun exposure, and human papilloma virus (HPV). Current research implicates HPV in nearly 14% of cases. Other research in familial aggregates of cancer reveals a possible genetic component in the development of oral cancer in younger patients. Another risk factor is the chewing of betel nut by males and females in India. As a result, oral cavity carcinoma is extremely prevalent in that country, representing nearly 45% of all cancers. The vast majority of oral cancers are squamous cell carcinomas (SCCA), which comprise 90% of all oral malignant lesions. Additional carcinomas include salivary gland tumors such as adenoid cystic or mucoepidermoid carcinomas, lymphoma, melanoma and the rare sarcomas or bone tumors.

Imaging plays a critical role in tumor staging is needed in evaluating the full deep extent of infiltration. This is necessary when assessing for the feasibility of surgical resection and/or radiation therapy and planning.

Oral cavity tumors are classified by site of origin. Awareness of a tumor's location and behavior is essential for adequate radiographic analysis as both tumor spread and the treatment options are variable. This section presents imaging examples of carcinoma and additional pathologies occurring in major sites including the floor of mouth, oral tongue, buccal mucosa, bony upper alveolus, hard palate, and retromolar trigone.

Neoplastic – critical imaging findings

In oral cavity cancers, tumor origin is important in determining its propensity to spread along certain pathways. Many papers discuss the multifactorial effects determining the prognosis in oral cavity cancers, however on imaging there are five major features that play a key prognostic role: tumor size and thickness, perineural invasion, bone marrow invasion, and lymph node involvement with extracapsular spread.

Multiple studies have demonstrated that increased tumor size is associated with decreased overall survival, thus the important T-factor on the AJCC chart. The T-factor affects both the five-year survival rates and rates of positive cervical lymphadenopathy. The comparative effects of the T-size with both survival rates and rates of metastatic lymphadenopathy, in a study by Tytor et al, for oral cavity SCCa are listed below:

- T1 - tumor 2 cm or smaller: 91% survival rate - 14% rate of positive lymph nodes
- T2 - tumor > 2 cm < 4 cm: 63% survival rate - 37% rate of positive lymph nodes
- T3 - tumor > 4 cm: 60% survival rate - 57% rate of positive lymph nodes

In the oral tongue, tumor thickness is an important prognostic factor in the risk of local recurrence, the presence of nodal metastasis, and overall patient morbidity and mortality. MRI allows for adequate measurement of the tumor thickness and often helps in assisting physicians/patients in treatment planning.

An additional important prognostic factor is tumor invasion of the perineural sheath or epineurium. A study by Brown et al noted an incidence of regional metastatic disease in 71% of patients with perineural invasion. This number is nearly double the incidence of metastatic disease which was found in only 36% of patients with oral cavity carcinomas with no perineural invasion. Local control rates also drop from 78% in patients without perineural invasion to 38% if perineural invasion was present. Thus perineural invasion is strongly associated with decreased survival and increased local recurrence requiring aggressive treatment.

Bone marrow invasion is a finding on the AJCC chart that upstages a lip carcinoma to a T4. Ct is very sensitive in assessing for cortical bony invasion. MRI can provide further information as to the status of the central marrow space in affected bones.

The presence or absence of lymphadenopathy is often considered one of the most important prognostic factors. This is discussed separately in the chapter Lymphadenopathy in the Head and Neck.

Lip carcinoma

Carcinomas of the lip usually arise from the vermillion border and may spread to involve adjacent skin or underlying muscles of the mouth such as the orbicularis oris. Small early lesions are often easier to detect on clinical examination. The role of imaging comes into play when the lesion may be more advanced and the margins indeterminate. The goal of imaging is to determine the full extent of the lesion, including possible perineural spread and the integrity of the adjacent bone (**Figures 7.5 and 7.6**). CT is very sensitive to assess for subtle bony erosive changes. MRI is superior for assessment of central bone marrow involvement. Care must be taken in MRI as it may overestimate the extent of tumor invasion with false positive findings secondary to hemorrhage and inflammatory change.

Floor of mouth carcinoma

The majority of SCCa's arise near the anterior midline floor of mouth. Floor of mouth carcinomas (**Figure 7.7**) have a propensity for lateral spread with involvement of the adjacent mandible or submucosally to involve the ipsilateral or contralateral lingual neurovascular bundle in the sublingual compartment. Assessment as to whether tumor has crossed the midline lingual septum or involves the contralateral neurovascular bundles are factors that will influence whether a surgeon will attempt a hemiglossectomy or total glossectomy. Additional critical factors that may upstage a FOM cancer to a stage 4 include, bone involvement, extension to the base of tongue and beyond the posterior edge of the mylohyoid muscle into the neck. Other radiographic findings in FOM carcinoma may include secondary dilatation

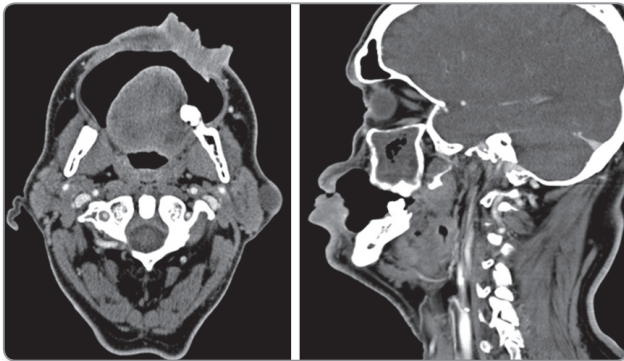


Figure 7.5 Axial and sagittal CT imaging of a large ulcerated mass involving the left lower lip. This scan was performed with a puffed cheek technique. This helps distend the gingivolabial sulcus and shows that there is no tumor extension onto the mandible.

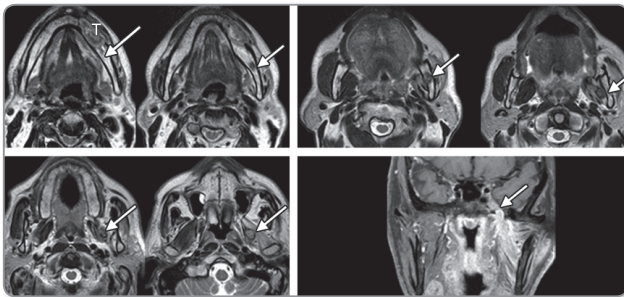


Figure 7.6 MRI imaging shows a lip carcinoma which had invaded deeply to involve the mandible (T). The arrows show perineural tumor spread along the inferior alveolar nerve in the mandible and then along the mandibular division of the trigeminal nerve in the masticator space. The coronal fat saturated post gadolinium enhanced image reveal tumor tracking back to the cavernous sinus.

of the salivary ducts secondary to tumor obstruction (**Figure 7.8**). Lymph node drainage pathways that need to be assessed include level IA, IB and internal jugular lymph nodes.

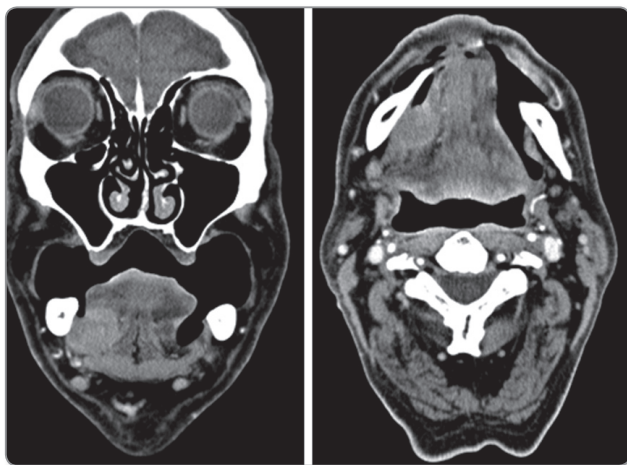


Figure 7.7 Contrast enhanced CT imaging with distension of the cheeks shows a hyperdense carcinoma involving the right floor of mouth mucosa. There is medial extension into the sublingual compartment. Bone algorithm images (not shown) did not reveal bone erosion.

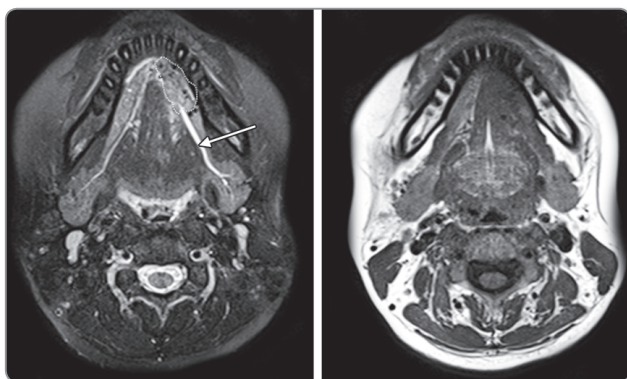


Figure 7.8 Dashed line outlines a mucoepidermoid carcinoma involving the left FOM. Note secondary dilatation (arrow) of the submandibular duct due to obstruction by the tumor.

Upper and lower alveolus and gingiva and buccal mucosa

Although tumors of the gingiva account for less than 10% of oral cavity carcinomas, the proximity of these tumors to bony cortical margins will increase the risk for potential bone and perineural extension (**Figure 7.9**). Buccal carcinomas most commonly originate along the lateral margins. The most common routes of spread include lateral submucosal extension into the buccinator muscle and posteriorly towards the pterygomandibular raphe and subsequent bony involvement.

Oral tongue

Approximately 16-22% of oral cavity SCCa arises in the tongue. Tumors present as a non-healing ulcer or as a neck (nodal) mass. Most oral tongue squamous cells carcinomas arise from the lateral undersurface of the tongue. Imaging should specifically assess whether there is extension across the midline raphe, invasion of the FOM, and the status of the adjacent mandible. Extension across midline may indicate the need for total glossectomy (**Figures 7.10 and 7.11**). Involvement

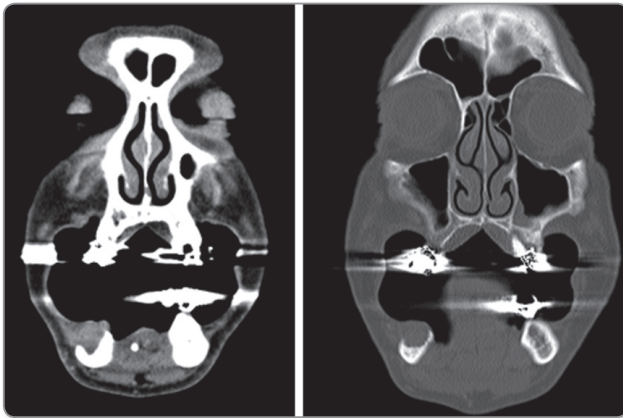


Figure 7.9 Coronal CT demonstrating a carcinoma involving the right mandibular alveolus.

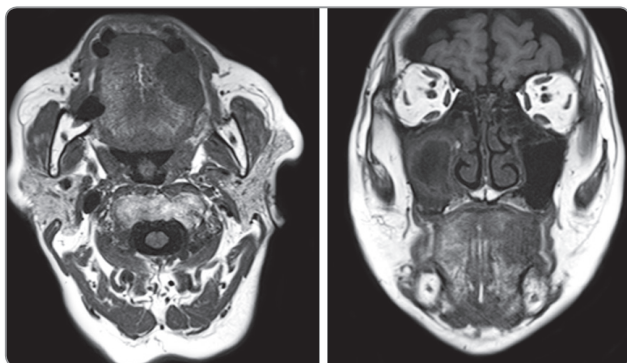


Figure 7.10 MRI of a left lateral oral tongue carcinoma. The lesion does not invade the tongue base or sublingual space and spares the midline.

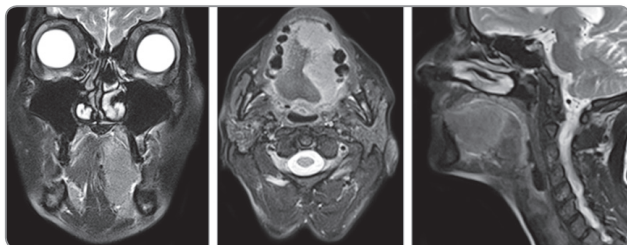


Figure 7.11 T2 weighted MRI shows a large carcinoma involving the entire left oral tongue. Coronal scan shows extension into the sublingual space. The tumor is also crossing the midline anteriorly.

of the tongue base is also important to identify as there would be potential for disease extension across the glossotonsillar sulcus onto the oropharyngeal wall.

Hard palate

Evaluation of hard palate SCCa requires careful assessment for bony palate destruction as well as for perineural tumor spread. While SCCa

can also give rise to perineural tumor spread, adenoid cystic carcinomas can also arise in the palate. These tumors have a high propensity for perineural tumor spread. In the palate, such perineural disease can extend along the greater and lesser palatine nerves (**Figures 7.12 and 7.13**) and eventually into the pterygopalatine fossa. Once

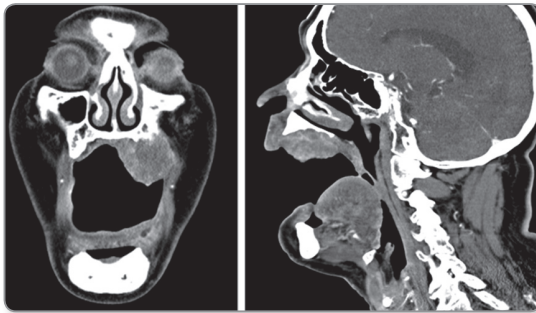


Figure 7.12 CT imaging shows a large lobulated carcinoma involving the lingual surface of the left hard palate. Even without the bone algorithm images, there is clear erosion of the left maxillary alveolus.

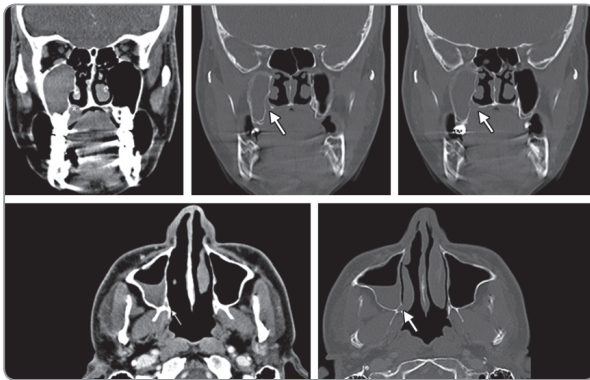


Figure 7.13 Another patient with an adenoid cystic carcinoma involving the right hard palate (asterisk). Note the enlargement of the right greater palatine nerve canal and increased soft tissue density within it. Perineural tumor spread was confirmed at the time of surgery.

tumor has reached the pterygopalatine fossa there will be further routes for perineural tumor spread including along CNV2 into foramen rotundum or anteriorly along the infraorbital nerve. Tumor may also spread along the Vidian nerve in the Vidian canal. The Vidian nerve is a combination of the greater superficial petrosal nerve (GSPN) and deep petrosal nerve. All of these nerves serve as routes for potential perineural tumoral spread into skull base and cavernous sinus.

Retromolar trigone

Retromolar trigone (RMT) tumors account for 7% of tumors affecting the oral cavity. The retromolar trigone is situated behind the posterior molars and is the ridge of tissue posterior to the last mandibular molar that runs up along the ascending ramus. The RMT is a rather unique location as it is a junction point between the oral cavity, oropharynx, and nasopharynx. Muscles such as the buccinator and superior constrictor muscles insert into the retromolar trigone and can facilitate different routes of tumor growth. Beneath the mucosal surface of the retromolar trigone is the pterygomandibular raphe which attaches superiorly to the hook of the hamulus arising from the medial pterygoid plate and inferiorly to the posterior mylohyoid line of the mandible. This raphe allows tumor access to both the skull base and nasopharynx. Bony cortical involvement of the mandibular ramus must also be sought. Tumors involving the retromolar region can extend into the adjacent tonsillar fossa and masticator space (**Figures 7.14 and 7.15**).

Mandible and maxilla

The maxilla and mandible can be affected by a diverse range of pathologic processes. In addition to tumor, many developmental, metabolic, inflammatory, and traumatic lesions or disorders which affect the skeleton can present in the jaws. Numerous benign and malignant soft tissue tumors as well as metastatic malignancies may present centrally within the maxilla or mandible. SCCa can arise primarily within the substance of the mandible or invade the mandible from adjacent gingival or buccal primaries.

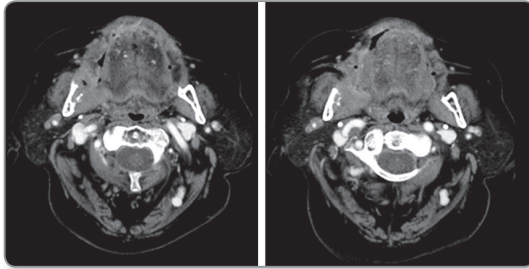


Figure 7.14 Infiltrative squamous carcinoma in the right retromolar trigone. There is asymmetric enlargement of the medial pterygoid muscle corresponding to masticator space involvement. Mandibular invasion is also evident.

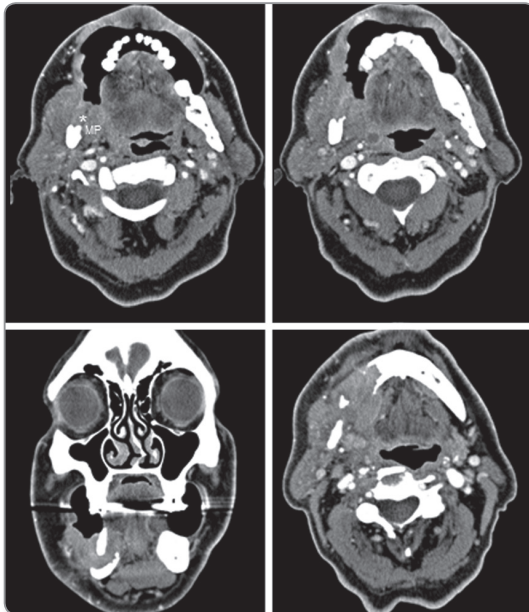


Figure 7.15 Large tumor mass centered in the right retromolar trigone (asterisk). There is contiguous extension to involve the medial pterygoid (MP) and anteriorly along the buccal mucosa. Tumor is also noted to have extended across the lower buccoalveolar sulcus to invade the right body of the mandible.

Given the presence of teeth and associated structures, there are also a variety of pathologies which are unique to the jaws. The goal of imaging in this region is not only to determine the extent of disease, but also to characterize the radiographic features as an aid in differential diagnosis and treatment planning. Assessment of lesional shape, borders, internal architecture, relationship and effects on surrounding teeth, expansion or perforation of cortical plates, and extension to soft tissue are fundamental to radiographic analysis.

Three jaw lesions that have fairly characteristic imaging appearances are the odontogenic keratocyst, the ameloblastoma and the dentigerous cyst.

The odontogenic keratocyst accounts for 10% of all jaw cysts. It arises from the dental lamina. Most arise in the posterior body of the mandible. These cysts are usually unilocular and have a characteristic epicenter located above the inferior alveolar nerve canal. They are minimally expansile and tend to enlarge along the long axis of the mandible (**Figure 7.16**).

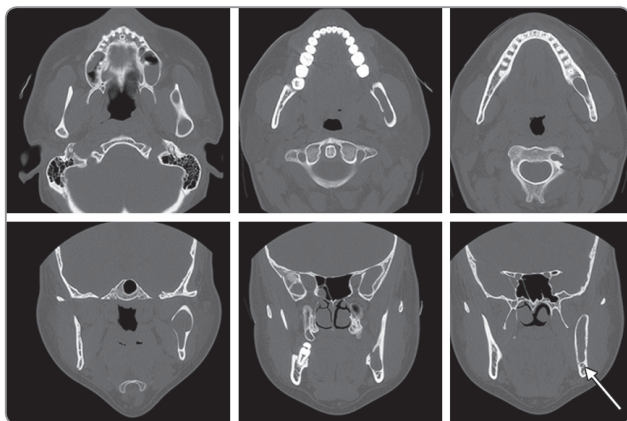


Figure 7.16 CT imaging of an odontogenic keratocyst. The lesion is mildly expansile and extends along the long axis of the mandible. The cyst epicenter is above the inferior alveolar nerve canal (arrow).

An ameloblastoma is a locally aggressive neoplasm that originates from odontogenic epithelium. It is the most common odontogenic tumor. It has a characteristic expansile, multiloculated cystic appearance. MRI may reveal the presence of a mural nodule. It most commonly affects the posterior mandible (**Figures 7.17 and 7.18**).

A dentigerous cyst is the second most common jaw cyst. They have a characteristic location around the crown (pericoronal) of an unerupted tooth which is usually a posterior mandibular molar. The cyst will always insert at the cemento-enamel junction of the tooth (**Figure 7.19**). Dentigerous cysts can also arise in the maxilla. In these

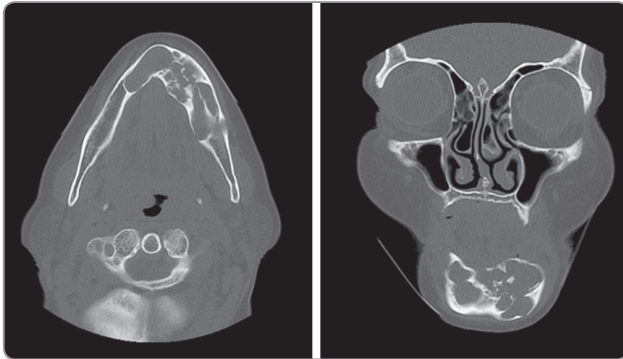


Figure 7.17 CT imaging of an ameloblastoma involving the mandibular symphysis and left body of the mandible. These tumors have a characteristic bubbly expansile appearance.



Figure 7.18 Another ameloblastoma. These are expansile lesions that can demonstrate internal scalloped margins and a central enhancing soft tissue component.

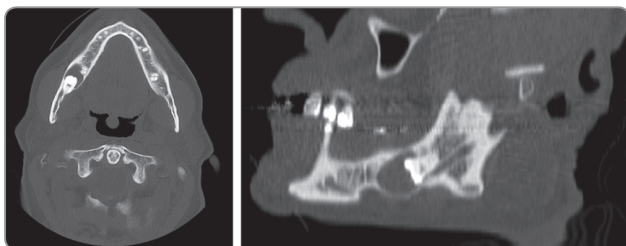


Figure 7.19 Dentigerous cyst located in the right posterior mandible. The cyst arises from the crown of an unerupted mandibular molar.

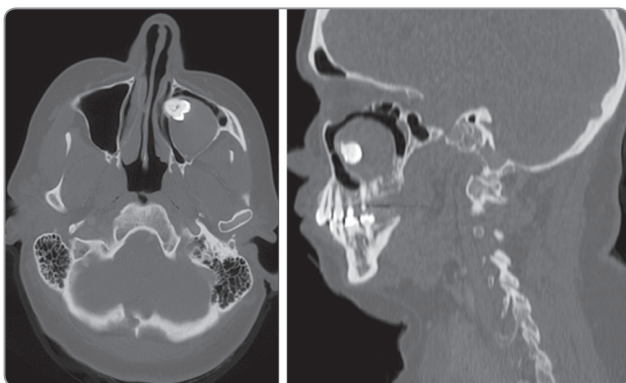


Figure 7.20 Another dentigerous cyst arising from the right maxilla. The cyst and its associated unerupted tooth have extended into the right maxillary antrum. Images courtesy of Dr Eric Bartlett.

instances, the unerupted tooth and cyst can prolapse into the maxillary antrum (**Figure 7.20**).

Another type of growth that affects the jaws and palate are bony exostosis. These are bony hyperplasias of bone that can arise along the lingual aspect of the hard palate (torus palatinus) and along the lingual aspect of the mandible (torus mandibularis). On imaging, these appear as very dense lobulated bony protrusions (**Figure 7.21**).

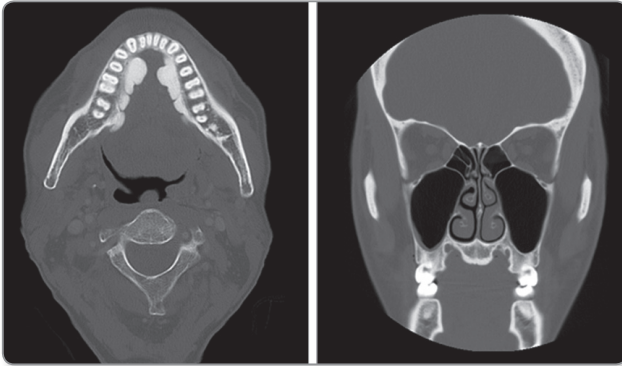


Figure 7.21 CT imaging in two different patients with tori involving the jaws. The left image shows dense lobulated calcified exostoses along the inner margin of the mandible – torus mandibularis. The coronal Ct shows a protruberant torus palatinus along the undersurface of the hard palate.

AJCC staging

The American Joint Committee on Cancer (AJCC) has designated staging by TNM classification.

TNM definitions

Primary tumor (T)

- TX: Primary tumor cannot be assessed
- T0: No evidence of primary tumor
- Tis: Carcinoma in situ
- T1: Tumor no larger than 2 cm in greatest dimension
- T2: Tumor larger than 2 cm but no larger than 4 cm in greatest dimension
- T3: Tumor larger than 4 cm in greatest dimension
- T4: (lip) Tumor invades through cortical bone, inferior alveolar nerve, floor of mouth, or skin of face, i.e. chin or nose:
 - T4a: (oral cavity) Tumor invades adjacent structures (e.g., through cortical bone, into deep [extrinsic] muscle of tongue

[genioglossus, hyoglossus, palatoglossus, and styloglossus], maxillary sinus, and skin of face)

- T4b: Tumor invades masticator space, pterygoid plates, or skull base and/or encases internal carotid artery

[Note: Superficial erosion alone of bone/tooth socket by gingival primary is not sufficient to classify a tumor as T4.]

Regional lymph nodes (N)

- NX: Regional lymph nodes cannot be assessed
- N0: No regional lymph node metastasis
- N1: Metastasis in a single ipsilateral lymph node, no larger than 3 cm in greatest dimension
- N2: Metastasis in a single ipsilateral lymph node, larger than 3 cm but no larger than 6 cm in greatest dimension; or in multiple ipsilateral lymph nodes, no larger than 6 cm in greatest dimension; or in bilateral or contralateral lymph nodes, no larger than 6 cm in greatest dimension
 - N2a: Metastasis in a single ipsilateral lymph node larger than 3 cm but no larger than 6 cm in dimension
 - N2b: Metastasis in multiple ipsilateral lymph nodes, no larger than 6 cm in greatest dimension
 - N2c: Metastasis in bilateral or contralateral lymph nodes, no larger than 6 cm in greatest dimension
- N3: Metastasis in a lymph node larger than 6 cm in greatest dimension

In clinical evaluation, the actual size of the nodal mass should be measured and allowance should be made for intervening soft tissues. Most masses larger than 3 cm in diameter are not single nodes but are confluent nodes or tumors in soft tissues of the neck. The three stages of clinically positive nodes are: N1, N2, and N3. The use of subgroups a, b, and c is not required but is recommended. Midline nodes are considered homolateral nodes.

Distant metastasis (M)

- MX: Distant metastasis cannot be assessed
- M0: No distant metastasis
- M1: Distant metastasis

AJCC Stage Groupings

Stage 0

- Tis, N0, M0

Stage I

- T1, N0, M0

Stage II

- T2, N0, M0

Stage III

- T3, N0, M0
- T1, N1, M0
- T2, N1, M0
- T3, N1, M0

Stage IVA

- T4a, N0, M0
- T4a, N1, M0
- T1, N2, M0
- T2, N2, M0
- T3, N2, M0
- T4a, N2, M0

Stage IVB

- Any T, N3, M0
- T4b, any N, M0

Stage IVC

- Any T, any N, M1

Degenerative

Denervation atrophy of the hypoglossal nerve (CNXII) is a process that can mimic the presence of a tongue mass. Initially the denervated tongue may be more swollen and over time, fatty replacement of the tongue musculature will occur. This can make the affected side appear larger and raise suspicion for an underlying tumor (**Figure 7.22**).

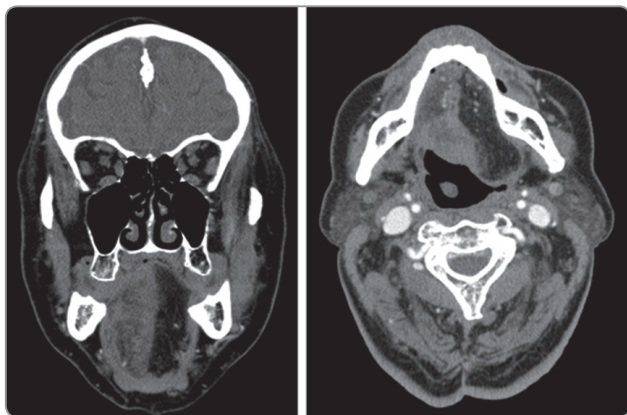


Figure 7.22 Example of tongue denervation. The affected left hemitongue demonstrates fatty atrophy. Axial imaging shows the tongue appears larger than the unaffected side. This could potentially give the impression of a left sided tumor mass.

Inflammatory

Inflammatory disorders of the oral cavity are multifold, and can include any of the inflammatory disease found elsewhere in the body. More specific inflammatory lesions of the oral cavity include herpetic gingivostomatitis and also Behcet's syndrome that can results in multiple oral ulcers similar to aphthous stomatitis (known more commonly as canker sores), pemphigoid, or condyloma (venerally transmitted warts).

Patients who have undergone radiation therapy to the oral cavity or nearby regions can occasionally develop osteoradionecrosis of the jaws. This can arise decades after initial therapy and is most common in the mandible. Patients will present with soft tissue swelling and pain. Bony exposure can arise. Pathologic fracture can also occur. Imaging shows features very similar to osteomyelitis such as cortical erosion, mixed areas of permeative internal lucency and sclerosis. Sequestra may also be seen (**Figure 7.23**).



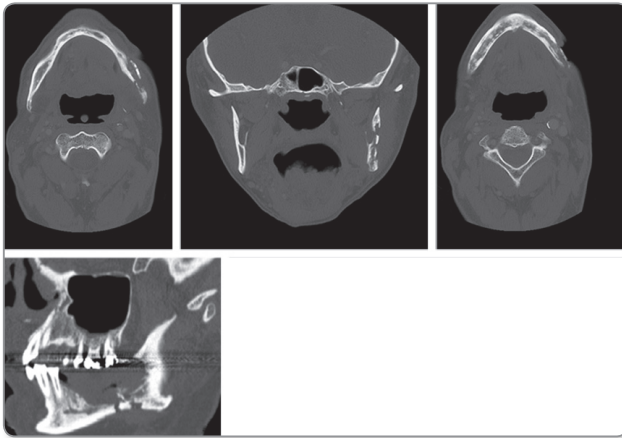


Figure 7.23 Radiation related osteoradionecrosis of the mandible in four different patients. Not the patchy erosive changes involving the cortex and internal marrow space. The third image shows loss of overlying soft tissue coverage. The last oblique sagittal reconstructed image shows the presence of a pathologic fracture.

Ranulas are mucous retention cysts that arise in the floor of mouth. They arise secondary to inflammation or trauma to the sublingual gland or minor salivary gland in the FOM. A simple ranula is a true-epithelial lined cyst that is present in the sublingual space. They appear as a well defined fluid density mass (**Figure 7.24**). A diving or plunging ranula arises when a simple ranula ruptures, spilling its contents into the surroundings. These resulting pseudocysts can often extend into the submandibular space but often still maintains a component in the sublingual region (**Figure 7.25**).



Congenital

Congenital and developmental lesions of the oral cavity include hemangiomas, lymphangiomas, lingual thyroid or thyroglossal duct cysts, teratomas and dermoid cysts.

Dermoid cysts are rare congenital epithelial inclusion cysts that contain both epithelial and dermal elements. Imaging can range from



Figure 7.24 Ranula of the left sublingual space. Imaging shows a well defined fluid density mass.

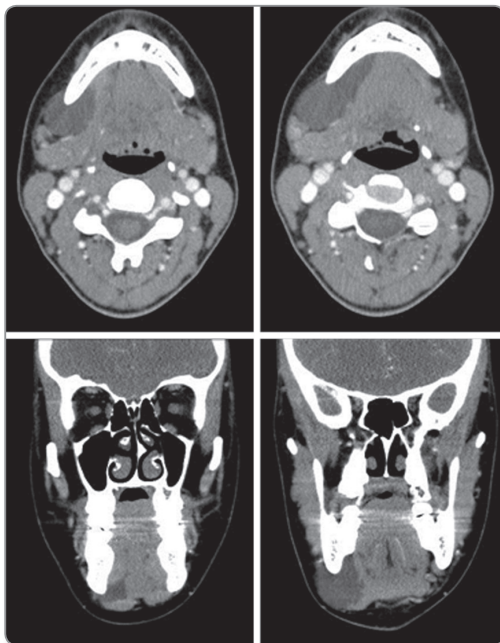


Figure 7.25 A diving ranula is a pseudocyst and appears as a fluid density mass that extends from the sublingual space into the submandibular compartment.



Figure 7.26 Imaging of dermoid cysts in three patients. Dermoids appear as cystic collections in the floor of mouth with internal foci of fatty attenuation. Some dermoids will show areas of internal calcification and may be trans-spacial with components spanning the sublingual and submandibular compartments.

the presence of a low attenuation fluid density mass to a complex mass with internal foci of rounded calcification and/or fat. They can involve the sublingual and or submandibular spaces (**Figure 7.26**).

In addition specific disorders such as Gorlin-Goltz syndrome or Basal cell nevus syndrome are associated with odontogenic keratocysts and epidermal cysts of the jaw, along with basal cell cancers, palmoplantar pits, calcified dura, and neoplasms including medulloblastoma, ovarian fibroma, lymphomesenteric cysts, fetal rhabdomyoma and bone anomalies include cleft lip and palate.

Traumatic

Fractures of the oral cavity are easily imaged by CT and can involve the mandible. Fractures may involve the symphysis and parasymphyseal regions with disruption of the genioglossus and digastric attachments. This can lead to posterior displacement of the tongue secondary to the unopposed suprahyoid musculature and blockage of the airway.

Conclusion

In summary, the anterior location and easy accessibility allow the unique anatomy of the oral cavity to be easily clinically inspected. However, lesions that extend below the submucosa including any of the various vascular, infectious, neoplastic, degenerative, inflamma-

tory, congenital, allergic and traumatic pathologies presented here, may be better evaluated on cross sectional imaging. CT as demonstrated here is excellent for bony detail and evaluation of odontogenic lesions. MRI allows for excellent evaluation of soft tissue detail, and both are often complementary

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