Extramucosal Spaces of the Head and Neck

Laurie A. Loevner and Jenny K. Hoang

Introduction

The extramucosal head and neck consists of several distinct spaces bounded by fascia [1, 2]. Knowing the anatomy of these spaces and their contents helps the radiologist to describe and correctly diagnose pathology. Some neck diseases are incidental findings while others are large enough to present as a palpable mass. Other diseases are not large, but in a location that leads to symptoms of ear pain, ear pressure/fullness, tinnitus, dysphagia, or cranial nerve palsies.

This article will discuss the rationale for evaluating these lesions and provide an approach in the radiologic assessment of extramucosal spaces of the head and neck with an emphasis on pertinent anatomy and correct localization of lesions. The spaces include the parapharyngeal space, carotid space, parotid space, masticator space, submandibular space, retropharyngeal space, and visceral space (Fig. 1). The perivertebral space will be discussed in another article.

Approach and Differential Diagnoses

When a radiologist encounters neck pathology, a systematic approach can help to diagnose the abnormality as well as provide information relevant to the patient's management. The steps in evaluating head and neck diseases are:

1. Localize the finding to the space of origin.
2. Describe the lesion characteristics including margins and morphology.
3. Describe the involvement or invasion of surrounding structures especially bones, muscles, vessels, and nerves.
4. Consider the differential diagnoses for the neck space along with the clinical history, and give the most likely differential first.

The differential diagnoses can be grouped into (1) space-specific diagnoses and (2) general neck diagnoses. Space-specific diagnoses are those that are unique to the space because it contains a structure that is not present in other neck spaces, for example, a major salivary gland, teeth, and carotid body. These space-specific differentials will be discussed in the following section. General neck diagnoses can arise in any neck space, although their frequency may differ depending on contents of the space. General neck diagnoses include nodal metastasis, lymphoma, mesenchymal tumors (sarcomas and lipomas), and vascular malformations. The most common primary tumors that metastasize to the neck are squamous cell cancer (SCC), thyroid cancer, and melanoma.

Extramucosal Spaces: Anatomy and Pathology

A thorough knowledge of the cross-sectional anatomy of the neck and skull base is essential in identifying pathology on imaging, in generating a succinct list of differential diagnoses based on lesion location and imaging appearance, and in determining the subsequent management.

Parapharyngeal Space

The parapharyngeal space (also known as the pre-styloid parapharyngeal) contains predominantly fat and is, therefore, easily identified on CT and MR imaging [3]. It extends from the skull base to the hyoid bone, merging with the submandibular space inferiorly. It is bordered by four spaces: anteriorly by the masticator space, laterally by the parotid space, medially by the pharynx, and posteriorly by the carotid space (post-styloid parapharyngeal space).

L.A. Loevner, MD
Radiology, Division of Neuroradiology, University of Pennsylvania Health System, 3400 Spruce Street, Philadelphia, PA 19104, USA
e-mail: laurieloevner@aol.com

J.K. Hoang (✉)
Radiology, Division of Neuroradiology, Duke University Medical Center, Erwin Road, Box 3808, Durham, NC 27710, USA
e-mail: jennykh@gmail.com

J. Hodler et al. (eds.), *Diseases of the Brain, Head and Neck, Spine 2016–2019: Diagnostic Imaging*, DOI 10.1007/978-3-319-30081-8_19

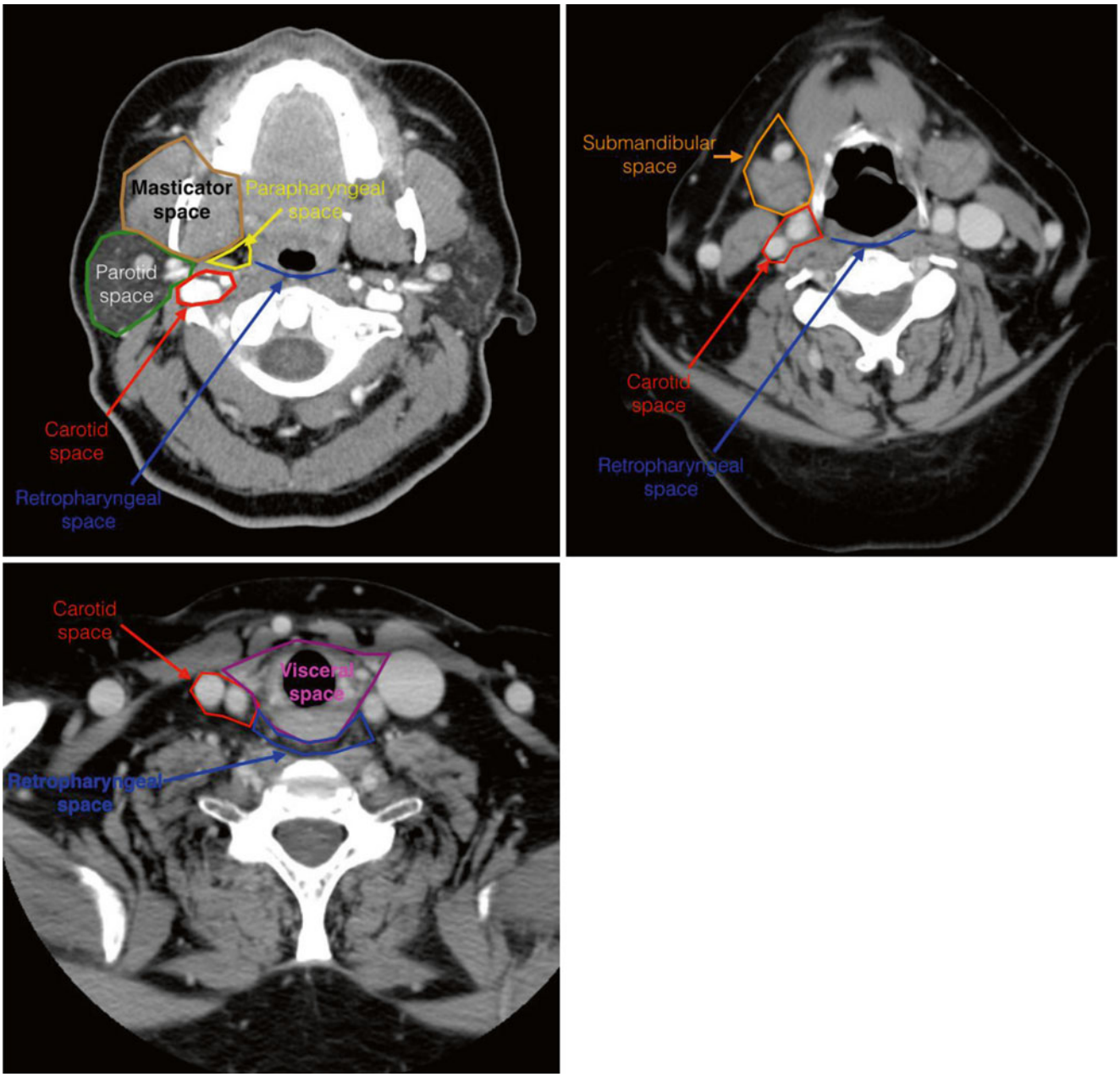

Fig. 1 Extramucosal spaces of the head and neck. The spaces are labelled on (**a**) contrasted CT of the suprahyoid neck, (**b**) contrasted CT at the level of the hyoid bone, and (**c**) contrasted CT of the infrahyoid neck

In addition to fat, the parapharyngeal space contains branches of the mandibular nerve (third division of the trigeminal nerve), branches of the external carotid artery (internal maxillary, middle meningeal, and ascending pharyngeal), the pterygoid venous plexus, minor salivary gland tissue, a lobule of the deep lobe of the parotid gland, and lymph nodes.

Pathology in the parapharyngeal space is usually due to extension of tumor or infection from the pharyngeal mucosa, the palatine tonsils, and/or an adjacent deep extramucosal space. Of the lesions arising primarily from the parapharyngeal space, the two main differentials are salivary tumors and schwannomas. Salivary gland tumors arise from the deep lobe of the parotid gland (Fig. 2) or from minor salivary rests. The majority of these salivary neoplasms are benign mixed tumors (pleomorphic adenomas), with the rest representing mucoepidermoid, adenoid cystic, and adenocarcinomas. It is important for the radiologist to attempt to distinguish whether a salivary neoplasm in the parapharyngeal space is arising from the deep lobe of the parotid gland or minor salivary tissue as this can affect surgical approach. Other less common lesions include

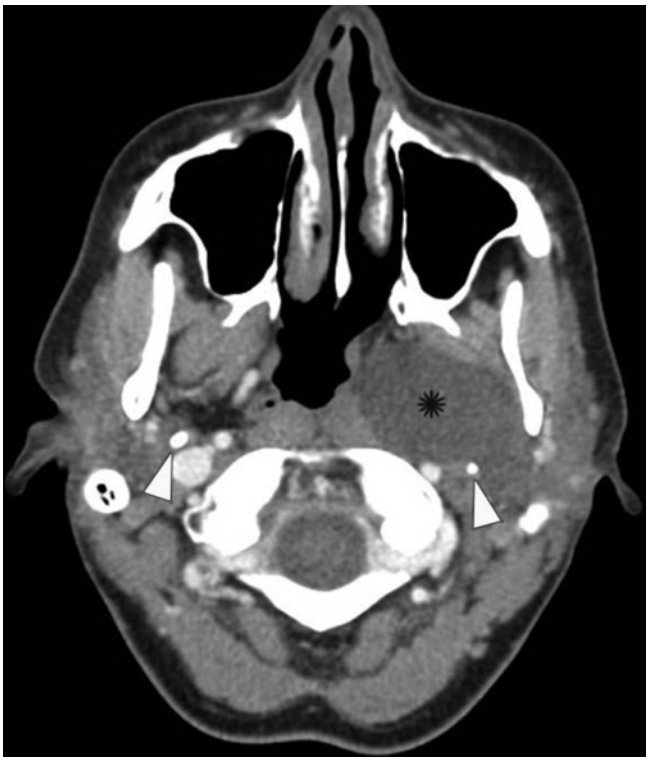

Fig. 2 Benign mixed tumor (pleomorphic adenoma). Axial contrast CT shows a low-attenuation mass (*asterisk*) in the left parapharyngeal space. The stylomandibular tunnel (styloid process [*arrowheads*] to mandible distance) is widened indicating that this parapharyngeal space arises from the deep lobe of the parotid gland

lymph nodes and cysts (retention and the rare branchial cleft cyst).

Tip Expansion of the stylomandibular tunnel indicates that the parapharyngeal mass arises from the deep lobe of the parotid (Fig. 2) [4].

Tip Direction of displacement of parapharyngeal fat can help to localize masses to one of the four surrounding spaces. A mass arising primarily from the parapharyngeal space will have a complete rim of surrounding fat.

Carotid Space (Post-styloid Parapharyngeal Space)

The carotid space (also referred to as the post-styloid parapharyngeal space) extends from the skull base to the aortic arch and contains the common and internal carotid arteries (ICAs), the internal jugular vein (IJV), deep cervical lymph nodes, cranial nerves IX–XII, and the cervical sympathetic plexus. In the suprahyoid neck, the carotid space is bordered anteriorly by the parapharyngeal space, and it sits anterior to the prevertebral space. The carotid sheath is comprised of all layers of the deep cervical fascia. The sheath is complete below the carotid bifurcation; however, it is often incomplete in the suprahyoid neck.

Lesions in the carotid space displace the parapharyngeal space/fat anteriorly. Since most pathology in this compartment arises behind the carotid artery, in the suprahyoid neck, most lesions in the carotid space displace the ICA anteriorly. Lesions here also tend to be radiologically characteristic. The most common carotid space lesion is an inflammatory or neoplastic jugular chain lymph node [5, 6]. Space-specific differential diagnoses of carotid space include schwannoma (Fig. 3), paraganglioma (Fig. 4), and pseudomass (jugular vein thrombosis, vascular ectasia, internal carotid artery pseudoaneurysm).

Tip Relationship of vessels to the mass helps to localize the mass within the carotid space. Masses arising from the vagus nerve will displace the ICA and IJV anteriorly or splay the ICA anteromedially and IJV posterolaterally (Fig. 3). Sympathetic chain masses displace the ICA and IJV anteromedially or posterolaterally. Carotid body masses splay the ICA and ECA (Fig. 4).

Tip In adults always consider metastatic disease in addition to a congenital cyst for a cystic neck mass in the carotid space. Cystic metastases may occur with thyroid cancer and SCC.

Parotid Space

The parotid space is bounded by the masticator space anteriorly, the parapharyngeal and carotid space medially, and the prevertebral space posteriorly. The facial nerve (CNVII) divides the parotid gland into the larger superficial and smaller deep lobes. The normal facial nerve is usually not seen on imaging, but the course can be mapped from the stylomastoid foramen to the lateral aspect of the retromandibular vein. Other contents of the parotid space include lymph nodes (intra- and extraparotid) and branches of the external carotid artery.

The most common tumor in the parotid space is a pleomorphic adenoma followed by Warthin tumor, mucoepidermoid carcinoma, and adenoid cystic carcinoma. However, given that the parotid gland contains lymph nodes, a parotid mass differential also includes lymphoma and metastasis. Nonneoplastic diseases in the parotid space include parotiditis, lymphoepithelial cysts, and branchial cleft cysts.

Tip Consider a primary parotid tumor in sites around the main parotid gland. The parotid can extend inferiorly below the mandible as the parotid tail and anteriorly over the masseter muscle as accessory parotid, and the deep lobe can extend into the parapharyngeal space (Fig. 2).

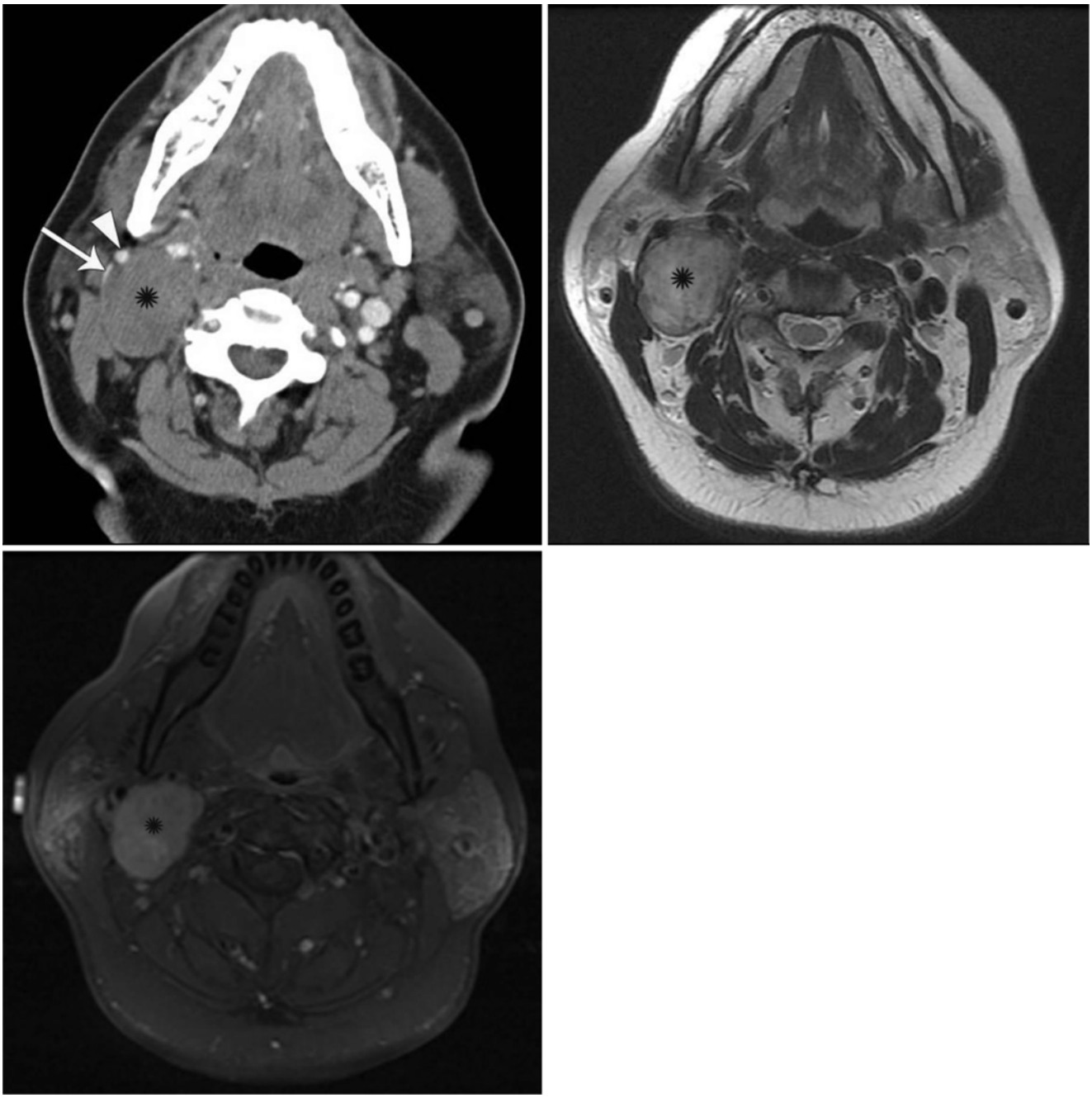

Fig. 3 Vagal schwannoma. (**a**) Axial contrast shows a low-attenuation mass (*asterisk*) in the right carotid space displacing the ICA (*arrowhead*) and IJV (*arrow*) anterolateral. (**b**) Axial T2-weighted and (**c**) enhanced fat suppressed T1-weighted image shows the mass (*asterisks*) has hyperintense T2 signal and homogenous enhancement

Tip It is particularly important to review the facial nerve to the stylomastoid foramen and within the temporal bone in patients with parotid malignancies since the facial nerve can be a path of perineural spread of tumor (Fig. 5).

Masticator Space

The inferior extent of the masticator space is the bottom of the mandible. Superiorly, the masticator space extends to the temporal fossa where the temporalis muscle inserts. It is bordered anteriorly by the buccal space, posteromedially by the parapharyngeal space, and posterolaterally by the parotid space. The masticator space contains the muscles of mastication (medial and lateral pterygoid, masseter, and temporalis muscles), the ramus and posterior body of the mandible, inferior alveolar arteries and veins, and masticator and inferior alveolar nerves. It may be divided into the infra-

temporal fossa and temporal fossa demarcated by the zygomatic arch. The investing fascia of the masticator space is the superficial layer of the deep cervical fascia. When lesions in the masticator space are large, the parapharyngeal space is displaced posteriorly or posteromedially.

Fig. 4 Carotid body paragangliomas. Axial contrast CT image shows vividly enhancing masses (*arrowheads*) in the carotid space bilaterally that between the ICA and ECA

The differential diagnosis of masticator space masses includes congenital/developmental lesions such as hemangiomas, lymphangiomas, and venolymphatic malformations, which frequently have radiologically characteristic appearances and are also frequently transpatial involving one or more of the extramucosal spaces as well as the mucosal surface of the adjacent pharynx. Infection in the masticator space secondary to odontogenic infections is also very common (Fig. 6). Finally, a mass in the masticator space could be a mesenchymal tumor. The role of the radiologist in this setting is to determine soft tissue versus bone origin and to look for findings that distinguish benign from malignant processes. The radiologist should be assessing for bone remodeling versus destruction, perineural spread along the trigeminal nerve, and the presence of matrix formation within the mass. In children malignant sarcomas are most common. In adults, schwannomas and metastatic disease are more common than primary sarcomas.

Tip Most masticator infections arise from the teeth, but sinus origin for infection should also be considered (Fig. 6).

Tip It is essential to review the bone windows for bony changes for any masticator space pathology.

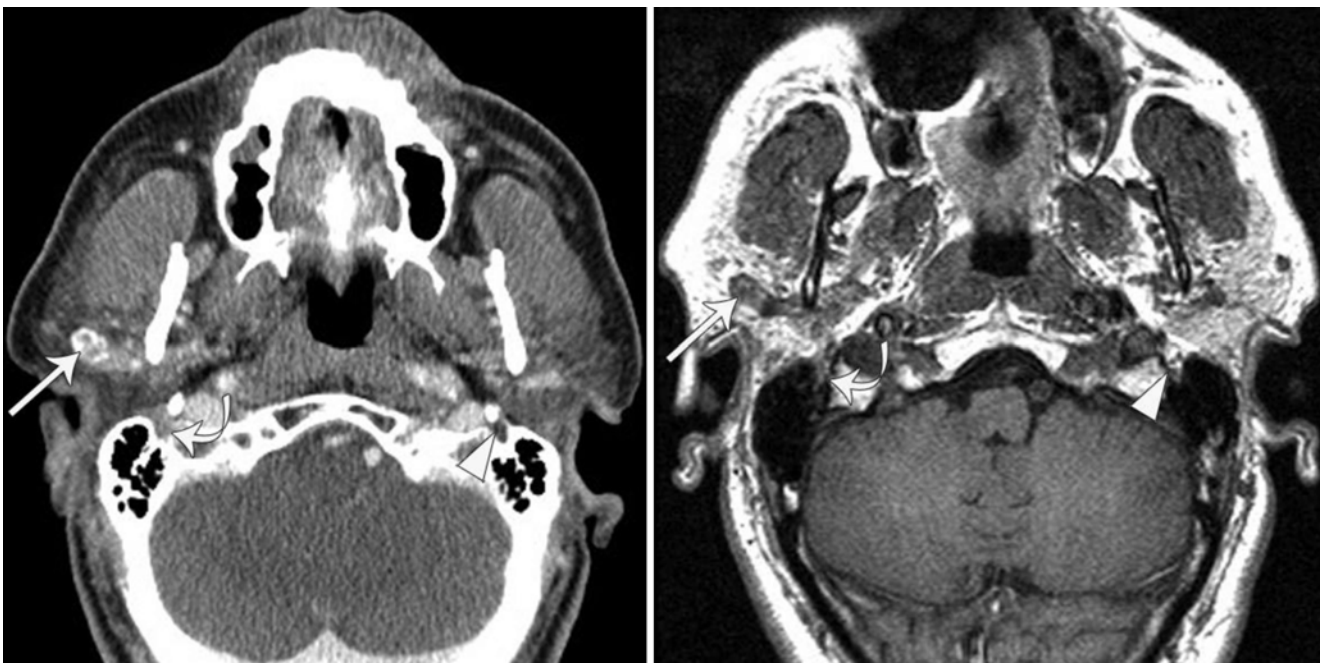

Fig. 5 Parotid ductal carcinoma with perineural spread of tumor. (**a**) Axial-enhanced CT and (**b**) T1-weighted MRI show partially calcified mass in the right parotid gland (*arrow*). The right stylomastoid foramen has soft tissue attenuation/signal (*curved arrow*) in contrast to the normal fat seen on the left side (*arrowhead*). This was due to perineural spread of tumor along CNVII

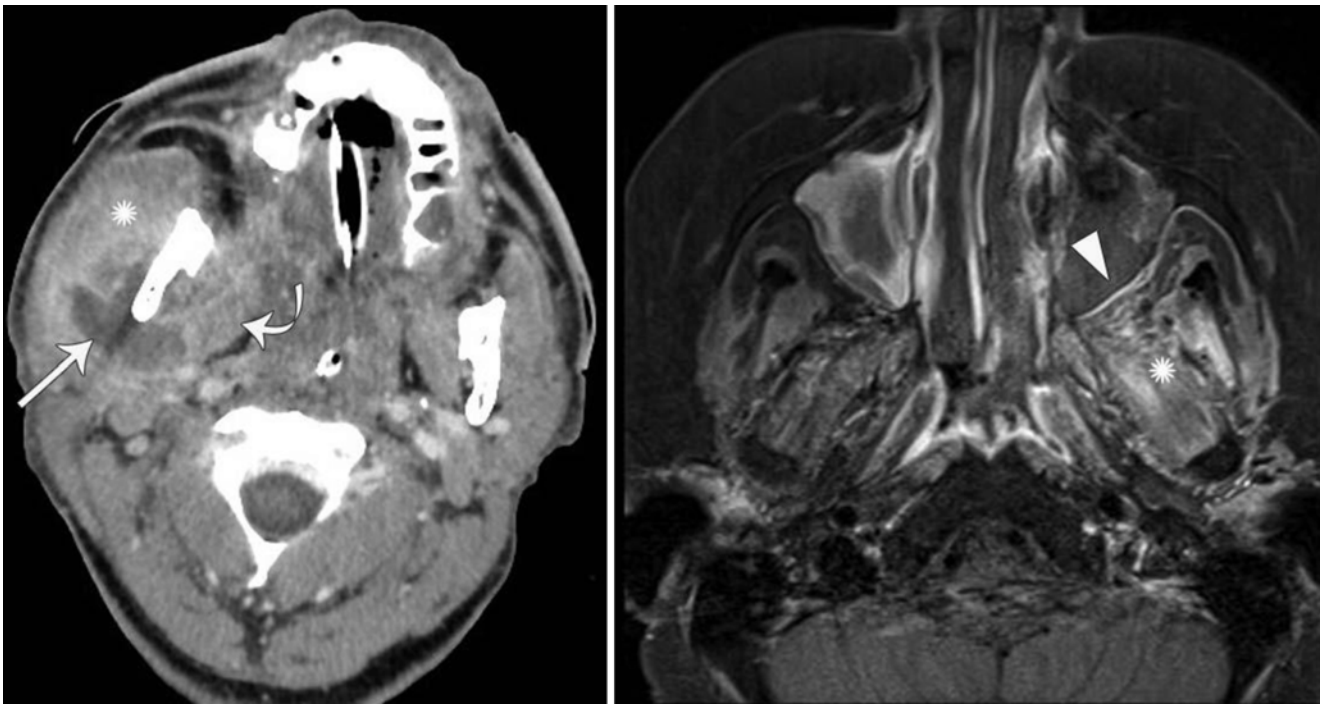

Fig. 6 Masticator space infections. (**a**) Bacterial abscess in the right masticator space (*arrow*) from odontogenic infection. The masseter (*asterisk*) and medial pterygoid (*curved arrow*) muscles are enlarged due to myositis. (**b**) Acute invasive fungal sinusitis with extension into the left masticator space (*asterisk*) resulting in increased enhancement. The left maxilla has lack of mucosal enhancement (*arrowhead*) in keeping with invasive fungal disease

Submandibular Space

The submandibular space is below the mylohyoid muscle and bordered by the carotid, sublingual, and masticator space [7]. The contents are the submandibular gland, submandibular nodes, facial vein and artery, and inferior loop of the facial nerve. The sublingual space lies above the mylohyoid muscle and is part of the oral cavity.

Like the parotid space, neoplastic differentials of the submandibular space include metastases, lymphoma, and primary tumors of the salivary gland. Pleomorphic adenoma is the most common benign primary tumor, but malignant tumors account for more than half of submandibular gland primary neoplasms [8]. The most common malignancies are adenocarcinoma and adenoid cystic carcinoma. Given the close proximity to the base of the tongue and floor of the mouth, there can also be direct extension of SCC to the submandibular space. Nonneoplastic pathologies of the submandibular space include sialoadenitis (viral or calculi) and diving ranula (Fig. 7).

Fig. 7 Diving ranula. Axial-enhanced CT shows a cystic mass (*asterisk*) in the left sublingual space and submandibular space. The left submandibular gland is displaced inferiorly relative to the right submandibular gland (*arrowhead*)

Retropharyngeal Space

The retropharyngeal space (RPS) is frequently seen on imaging as only a small 1–2 mm fat plane behind the pharynx (Fig. 1) [1, 9]. The RPS is divided into the true RPS anteriorly and danger space posteriorly. The true RPS extends from the skull base superiorly to the thoracic inlet inferiorly, but the "danger space" continues inferiorly to

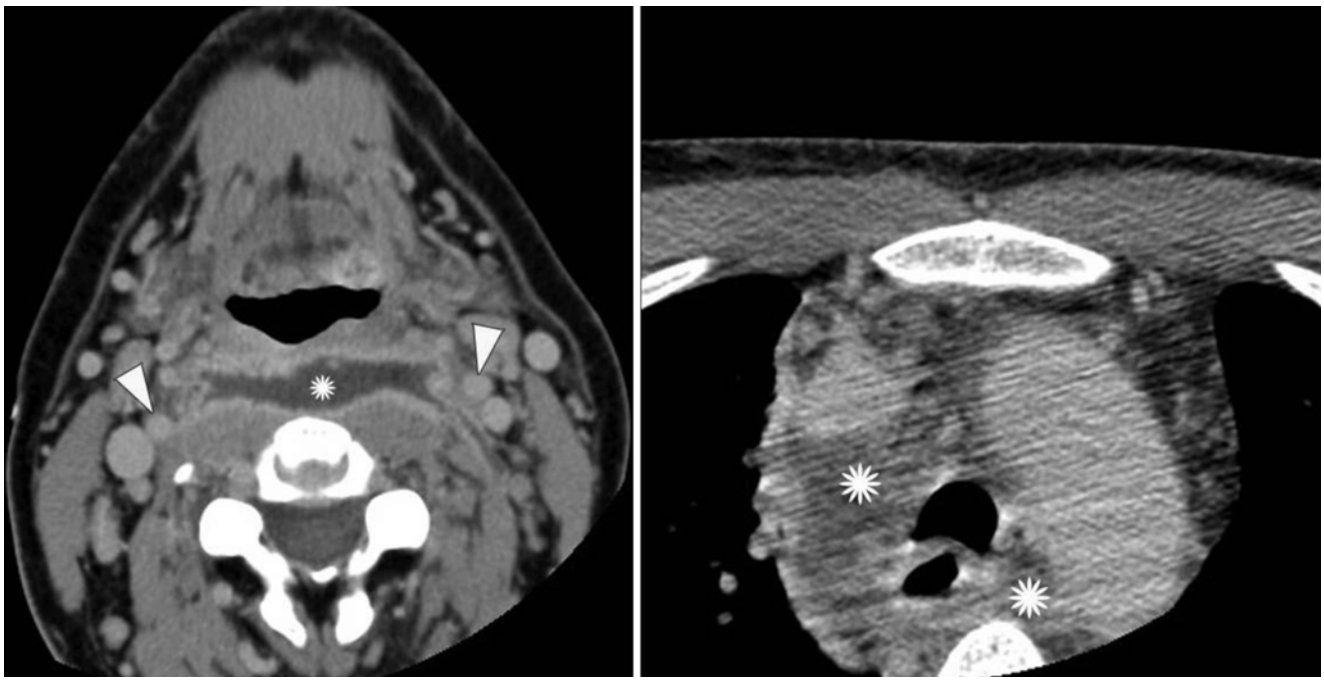

Fig. 8 Retropharyngeal abscess and mediastinitis. (**a**) Axial-enhanced CT demonstrates a rim-enhancing collection (*asterisk*) in retropharyngeal space spanning ICA-to-ICA (*arrowheads*). (**b**) Axial-enhanced image of the mediastinum shows fat stranding in keeping with mediastinitis

the crura of the diaphragm. The RPS is situated between the pharyngeal constrictor muscles that are anterior, the longus colli and capitis muscles that are posterior to this compartment, and the carotid space laterally. The RPS contains fat, lymph nodes, mesenchymal tissue, nerves, and lymphatics. In the suprahyoid neck, the RPS has abundant lymph nodes.

The differential diagnosis of retropharyngeal space pathology includes collections (effusion and abscess) (Fig. 8), adenopathy (inflammatory and nodal metastases), and neoplasms including schwannomas and the less common mesenchymal tumors (lipoma, rhabdomyoma, and sarcomas).

Tip RPS abscess spans the RPS from side to side is a surgical emergency that requires immediate drainage because of potential for spread of infection to the mediastinum (Fig. 8). A small unilateral collection in the RPS is usually a suppurative lymph node and not at immediate risk of spreading to the mediastinum.

Visceral Space

The visceral space is a single midline space surrounded by the middle layer of the deep cervical fascia and extends from the hyoid to the mediastinum. It contains the thyroid and parathyroid glands, hypopharynx and esophagus, larynx and trachea, paraesophageal nodes, and recurrent laryngeal nerves. The most common visceral space lesions are benign thyroid nodules and multinodular goiter [10, 11]. Preoperative imaging of thyroid carcinoma requires careful review of the structures that could be locally invaded such as the trachea, esophagus, vessels, and recurrent laryngeal nerve [12, 13].

Tip Not all incidental thyroid nodules seen on CT or MRI require workup. If there are no suspicious imaging findings or clinical history, the American College of Radiology (ACR) White Paper recommends ultrasound for nodules ≥1.5 cm in patients aged ≥35 years and ≥1 cm for patients aged <35 years [10].

Conclusion

A systematic approach to diagnosing diseases in the extramucosal head and neck first starts with understanding the boundaries and contents of the spaces. This is essential in order to generate a succinct list of differential diagnosis based on lesion location and imaging appearance and to identify important anatomy that may affect management. The differential diagnoses can be grouped into space-specific diagnoses and general neck diagnoses.

References

1. Harnsberger HR, Osborn AG (1991) Differential diagnosis of head and neck lesions based on their space of origin. 1. The suprahyoid part of the neck. AJR Am J Roentgenol 157(1):147–154
2. Smoker WR, Harnsberger HR (1991) Differential diagnosis of head and neck lesions based on their space of origin. 2. The infrahyoid portion of the neck. AJR Am J Roentgenol 157(1):155–159

3. Shin JH, Lee HK, Kim SY, Choi CG, Suh DC (2001) Imaging of parapharyngeal space lesions: focus on the prestyloid compartment. AJR Am J Roentgenol 177(6):1465–1470
4. Abrahams JJ, Culver RR, Kalra VB (2014) Stylomandibular tunnel widening versus narrowing: a useful tool in evaluating suprahyoid mass lesions. Clin Radiol 69(11):e450–e453
5. Hoang JK, Vanka J, Ludwig BJ, Glastonbury CM (2013) Evaluation of cervical lymph nodes in head and neck cancer with CT and MRI: tips, traps, and a systematic approach. AJR Am J Roentgenol 200(1):W17–W25
6. Gor DM, Langer JE, Loevner LA (2006) Imaging of cervical lymph nodes in head and neck cancer: the basics. Radiol Clin North Am 44(1):101–110, viii
7. Law CP, Chandra RV, Hoang JK, Phal PM (2011) Imaging the oral cavity: key concepts for the radiologist. Br J Radiol 84(1006):944–957
8. Rapidis AD, Stavrianos S, Lagogiannis G, Faratzis G (2004) Tumors of the submandibular gland: clinicopathologic analysis of 23 patients. J Oral Maxillofac Surg 62(10):1203–1208
9. Hoang JK, Branstetter BF, Eastwood JD, Glastonbury CM (2011) Multiplanar CT and MRI of collections in the retropharyngeal space: is it an abscess? AJR Am J Roentgenol 196(4):W426–W432
10. Hoang JK, Langer JE, Middleton WD et al (2015) Managing incidental thyroid nodules detected on imaging: white paper of the ACR Incidental Thyroid Findings Committee. J Am Coll Radiol 12(2):143–150
11. Loevner LA, Kaplan SL, Cunnane ME, Moonis G (2008) Cross-sectional imaging of the thyroid gland. Neuroimaging Clin N Am 18(3):445–461, vii
12. Hoang JK, Branstetter BF, Gafton AR, Lee WK, Glastonbury CM (2013) Imaging of thyroid carcinoma with CT and MRI: approaches to common scenarios. Cancer Imaging 13: 128–139
13. Hoang JK, Sosa JA, Nguyen XV, Galvin PL, Oldan JD (2015) Imaging thyroid disease: updates, imaging approach, and management pearls. Radiol Clin North Am 53(1):145–161