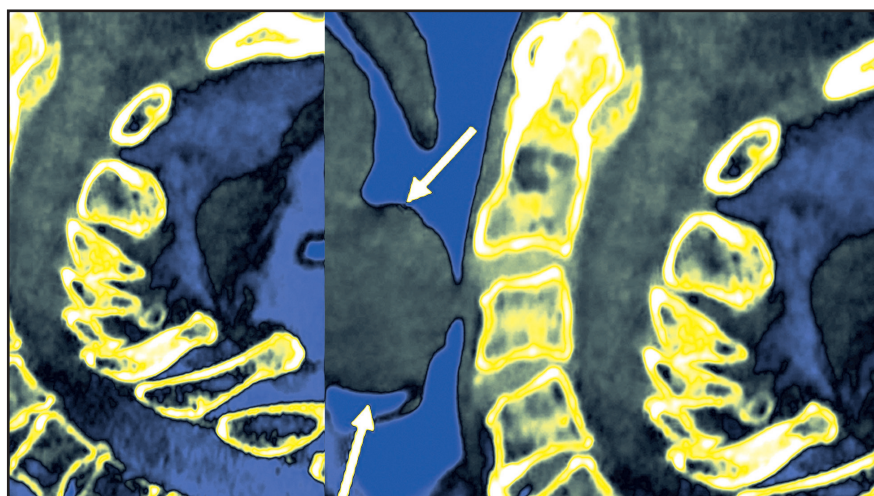


# A simplified approach to the spaces of the suprahyoid neck

Indu Rekha Meesa, MD, MS, and Suresh K. Mukherji, MD, MBA, FACR

**T**he spaces of the suprahyoid neck were originally described by anatomists and surgeons in the 19th century as they dissected the layers of the deep cervical fascia, attempting to better understand the extension of infections of the extracranial head and neck to other areas in the neck, chest, and abdomen.<sup>1</sup> This led to detailed categorization and descriptions of the cervical fascia and numerous soft tissue spaces that have been used by anatomists and otolaryngologists. However, due to the complexity and confusing array of terminology used to describe the deep cervical fascia, radiologists did not commonly use it.<sup>1,2</sup>

The advent of CT and MRI allowed radiologists to better visualize the complex anatomy and pathology of the suprahyoid neck. Then in the late 1980s and early 1990s, the spaces concept in the



neck was reintroduced from a radiologic perspective, which enabled the radiologists to better understand the spaces of the neck and their components (Table 1).<sup>2-8</sup> This article will present a discussion of each of the various spaces of the suprahyoid neck, along with a list of differential diagnoses pertinent to that space based on its anatomical contents.

## Spaces of the suprahyoid head, neck and fascia

The two main fascial layers of the suprahyoid neck are the superficial cervical fascia and the deep cervical fascia (DCF).

The superficial cervical fascia consists of the subcutaneous tissues of the head and neck. The DCF consists of the superficial, middle and deep layer. The middle layer (visceral or pharyngomucosal) encloses the pharynx, which includes the oropharynx and the nasopharynx. The deep layer (prevertebral) is posterior to the visceral fascia and defines the contents of the prevertebral space (PVS).<sup>9</sup>

## Visceral space

In the suprahyoid neck, the contents of the visceral space are the naso- and oropharynx, which have an epithelial

*Dr. Meesa is a Radiologist with Synergy Radiology, LLC, Fort Wayne, IN; and Dr. Mukherji is a Professor, The Walter F. Patenge Endowed Chair of the Department of Radiology, and Chief Medical Officer and Director of Health Care Delivery, at Michigan State University Health Team, East Lansing, MI.*

**Table 1. Spaces of the suprahyoid head and neck**

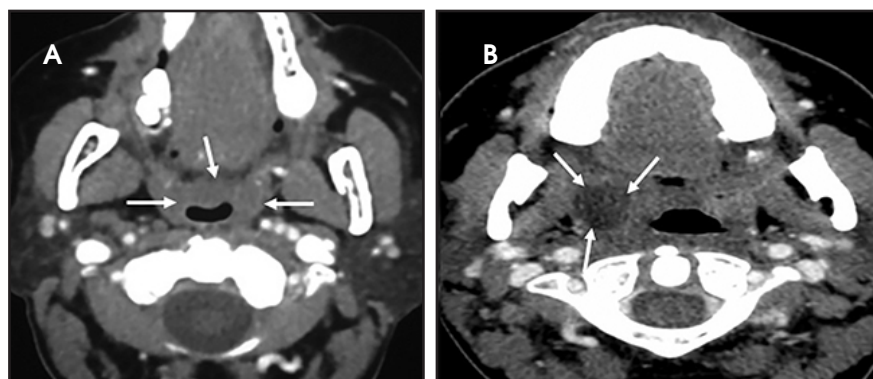
- Visceral (pharyngomucosal space)
- Retropharyngeal
- Prevertebral (perivertebral space)
- Parapharyngeal (prestyloid parapharyngeal)
- Carotid sheath (carotid, post styloid parapharyngeal)
- Masticator
- Buccal
- Parotid
- Sublingual
- Submandibular

lining (Figure 1A). In the infrahyoid neck, the fascia encircles the hypopharynx, larynx, and thyroid. Some of the important contents of the suprahyoid neck are the mucosa, lymphoid tissue of Waldeyer's ring (adenoids, tonsils), and minor salivary glands.<sup>2</sup>

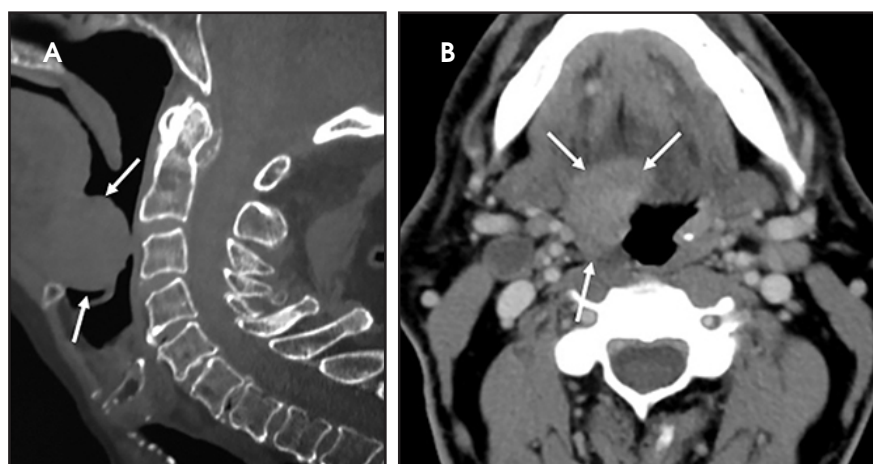
Some of the pathological processes that can occur within this space include malignant tumors, inflammatory lesions, infectious causes (tonsillar or peritonsillar abscess) and musculoskeletal tumors (Figures 1B, 2). With the epithelial lining, the most common malignancy in the visceral space is squamous cell carcinoma (SCC).<sup>2, 5, 10, 11</sup> The lymphatic tissue in the Waldeyer's ring can give rise to non-Hodgkin's lymphoma, the second-most common malignancy in the PMS.<sup>2</sup> The minor salivary glands can also give rise to both benign and malignant tumors.

### Retropharyngeal space

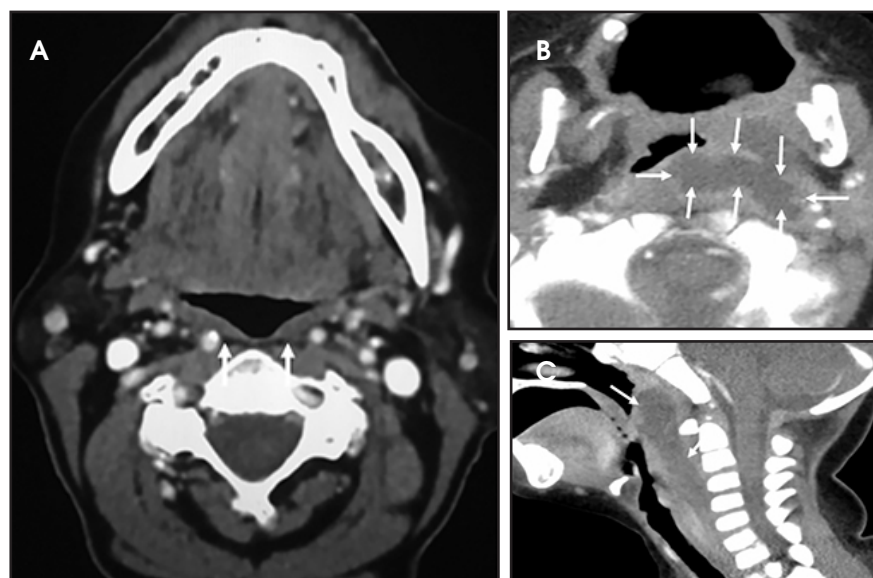
The retropharyngeal space (RPS) is bordered anteriorly by the visceral fascia and posteriorly by the prevertebral fascia and is commonly referred to as the "danger space."<sup>1</sup> A thin fascial layer (alar fascia) divides the RPS into anterior and posterior compartments. The anterior compartment extends from the skull base inferiorly to where the alar



**FIGURE 1.** (A) Axial contrast-enhanced CT of the neck demonstrates the visceral space (arrows). (B) Axial contrast-enhanced CT of the neck demonstrates a right peritonsillar abscess (arrows).

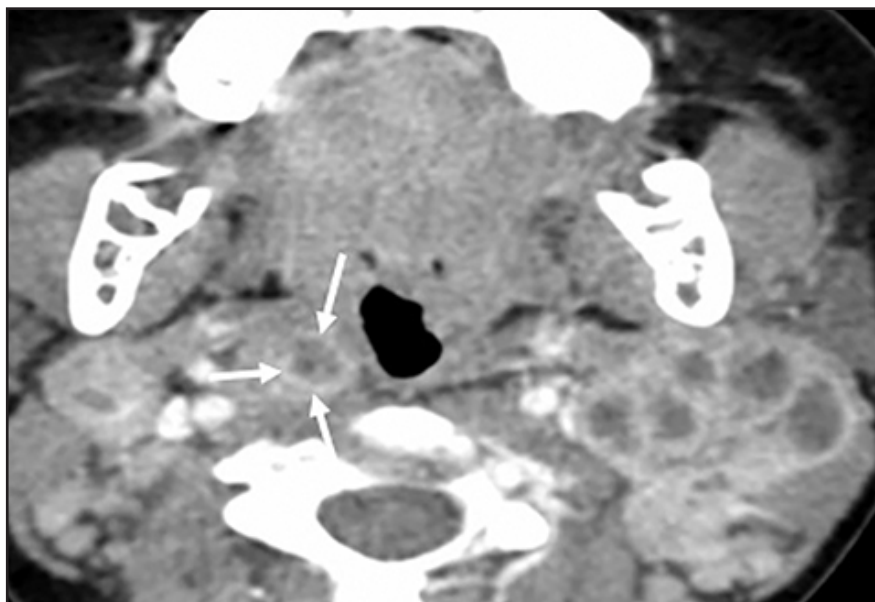


**FIGURE 2.** (A) Sagittal CT scan of the cervical spine demonstrates a soft tissue mass at the base of the tongue (arrows) (non-Hodgkins lymphoma). (B) Axial contrast-enhanced CT scan of the neck demonstrates soft tissue mass at the base of the tongue, squamous cell carcinoma (arrows).



**FIGURE 3.** (A) Axial CTA of the neck demonstrates retropharyngeal space (arrows) containing mainly fat and lymph nodes. (B, C) Axial and sagittal contrast-enhanced neck images demonstrate an ill-defined large irregular retropharyngeal space fluid collection (arrows).





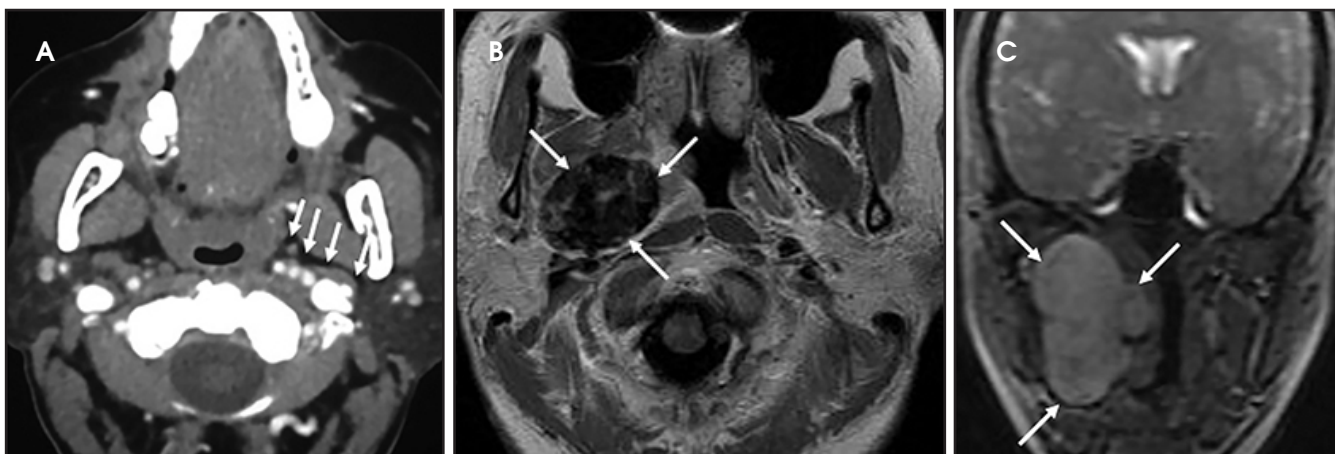
**FIGURE 4.** Axial contrast-enhanced CT scan demonstrate a necrotic retropharyngeal lymph node (arrows) in a patient with tuberculosis.

fascia fuses with the visceral fascia and the posterior compartment, the “danger space” that extends from the skull base to the diaphragm.<sup>1,2,4,9</sup> The contents of the RPS are fat and retropharyngeal lymph nodes (RPLN), sometimes referred to as the nodes of Rouviere (Figure 3A).

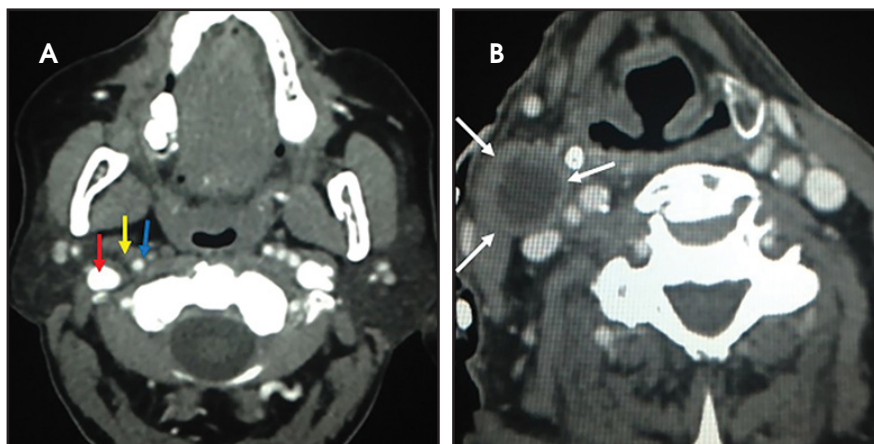
The differential diagnoses for primary retropharyngeal processes include edema, cellulitis and abscess (Figures 3B and 3C). Differential diagnoses for secondary extension into the RPS include direct extension from squamous cell carcinoma, tortuous carotid artery, lipoma, hemangioma, diskitis and osteomyelitis from the prevertebral space. For the lymph nodes, differential diagnoses include reactive adenopathy, suppurative adenitis, metastatic adenopathy, and lymphoma (Figure 4).<sup>1</sup>



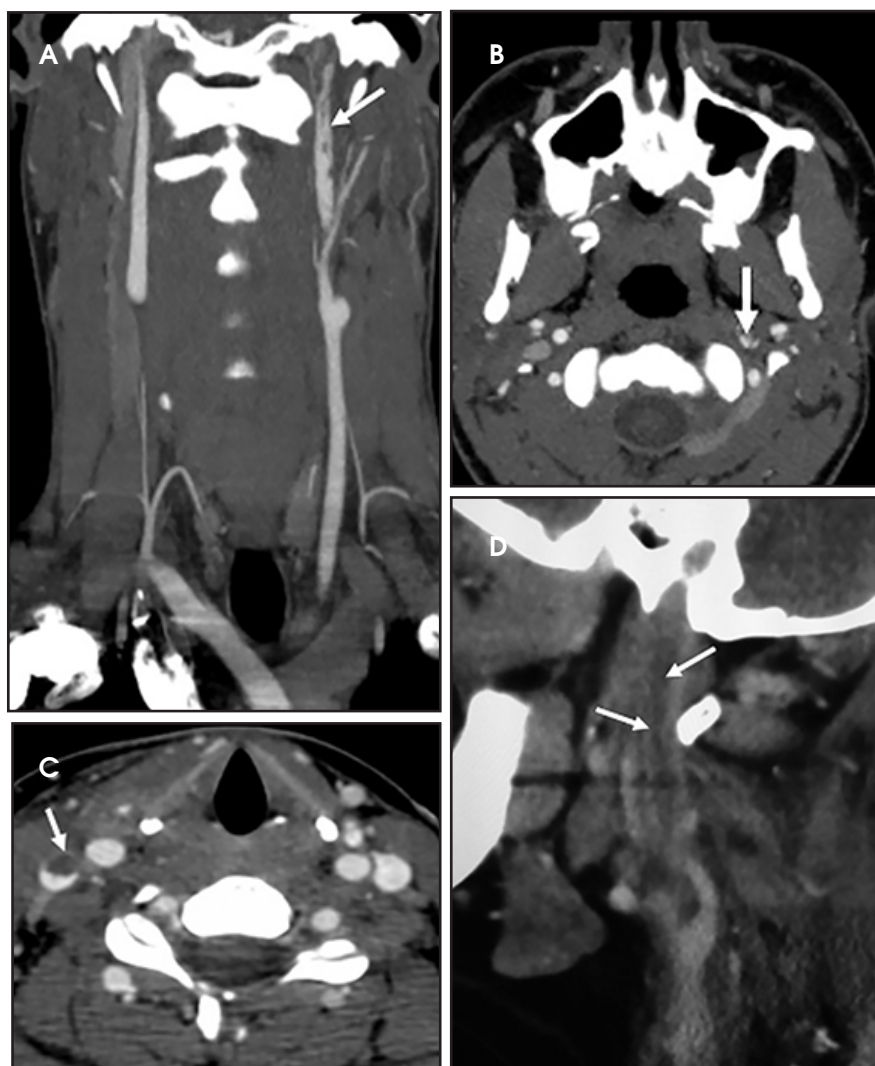
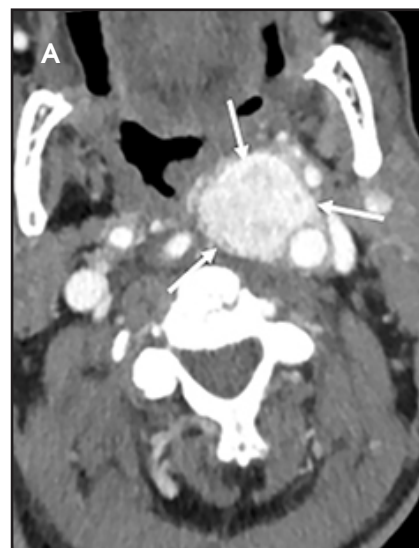
**FIGURE 5.** (A) The prevertebral space (arrows) is outlined by arrows. (B) Axial contrast-enhanced CT of the neck demonstrates calcification in the prevertebral musculature (arrows). (C) Sagittal STIR sequences demonstrate edema in the prevertebral muscles (arrows).



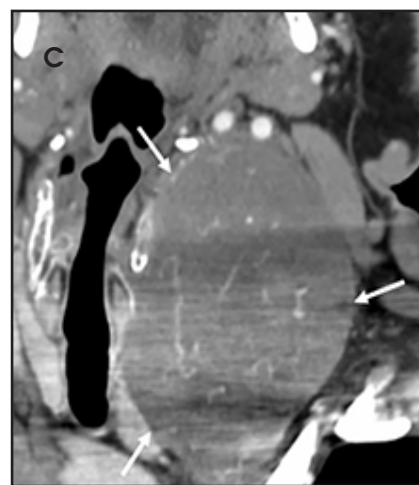
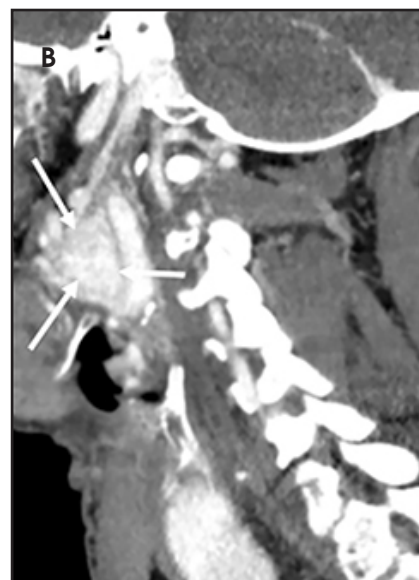
**FIGURE 6.** (A) Axial contrast-enhanced neck CT demonstrates the parapharyngeal space (arrows), containing mainly fat, vascular structures, and small branches of the mandibular division of the fifth cranial nerve. (B, C) Axial and coronal T1- and T2-weighted MRI sequences demonstrate a pleomorphic adenoma arising from the deep lobe of the parotid gland (arrows).



**FIGURE 7.** (A) Carotid sheath contains internal jugular vein (red arrow), internal carotid artery (blue arrow), lymph nodes (yellow arrow), sympathetic chain, cranial nerves IX to XII. (B) Axial contrast-enhanced neck CT demonstrates a metastatic necrotic lymph node (arrows) in the carotid space in a patient with SCC of base of tongue.



**FIGURE 8.** (A, B) Coronal and axial contrast-enhanced neck CTA images demonstrate carotid artery dissection (arrows). (C, D) Axial and sagittal contrast-enhanced neck CT images demonstrate thrombosed jugular veins (arrows).

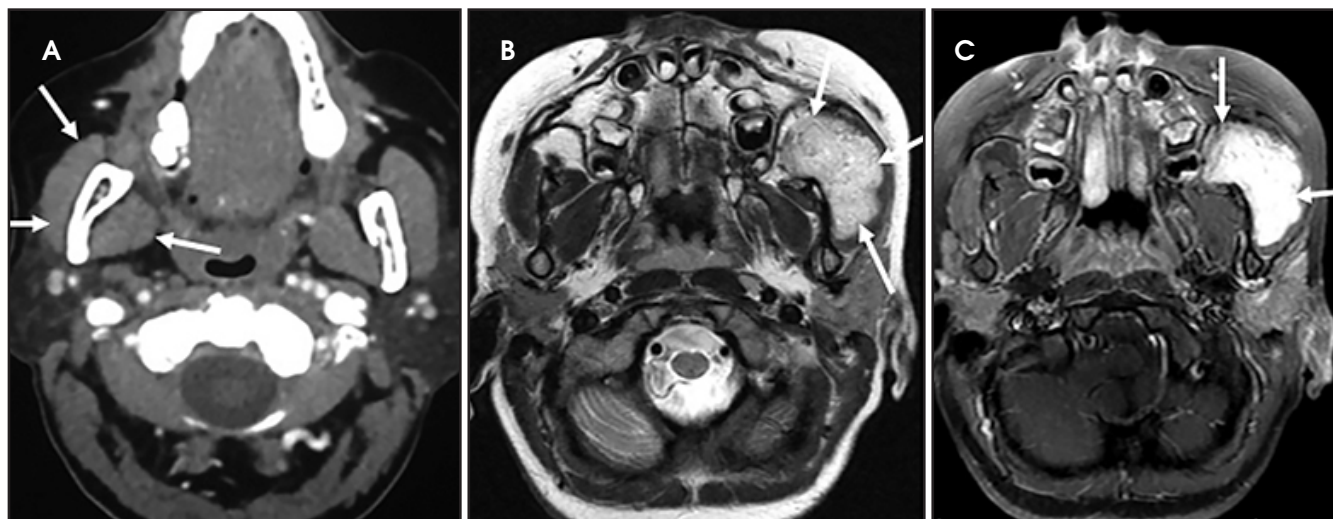


**FIGURE 9.** (A, B) Carotid body tumor splaying the carotid arteries (arrows). (C) Nerve sheath tumor in the carotid space (arrows).



**Table 2. Anatomically-based differential diagnosis for carotid sheath pathology**

- Lymph nodes: Metastatic cervical adenopathy, inflammatory, lymphoma (Figure 7B).
- Carotid artery: Aneurysm, pseudoaneurysm, dissection, encasement by direct spread of SCC (Figures 8A,8B).
- Jugular vein: Asymmetric enlarged jugular vein, thrombosis, thrombophlebitis, meningioma (Figures 8C, 8D).
- Cranial nerves IX to XII, sympathetic chain: neurogenic tumor, neuroblastoma, paraganglioma (Figure 9).


**FIGURE 10.** (A) Masticator space (arrows) outlined by the muscle of mastication. (B, C) Avidly enhancing masseter muscle diagnosed as hemangioma (arrows).

**Table 3. Anatomically-based differential diagnosis for the masticator space**

- Muscles of mastication: Mesenchymal lesions (benign and malignant, such as hemangiomas and sarcomas), lymphoma, benign masseteric hypertrophy, denervation atrophy, idiopathic fibrosis, metastases, myositis ossificans (Figures 10B, 10C).
- Mandibular branch of V3: Neurogenic tumor, perineural spread of tumor
- Mandible: Osteomyelitis, odontogenic abscess, primary jaw lesions, metastases, myeloma (Figure 11).
- Secondary extension into MS: deep spread of SCC from oropharynx or retromolar trigone, inferior extension of intracranial or skull base lesions.

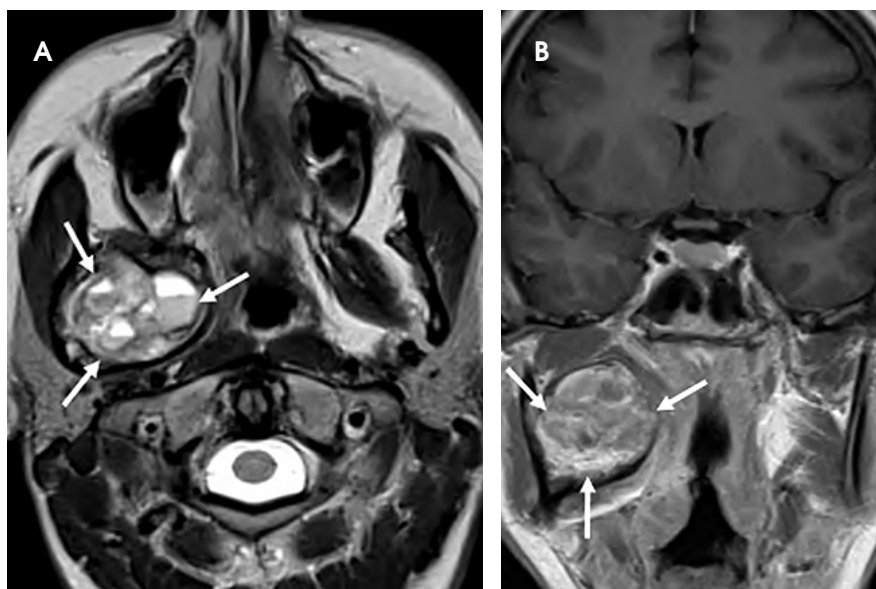
### Prevertebral space

The prevertebral space (PVS) is posterior to the retropharyngeal space and is enclosed by the prevertebral fascia.<sup>1</sup> The anatomic components of the PVS in the suprahyoid neck include the following: Prevertebral muscles (longus colli capitis), vertebral body, cervical disk, spinal canal, vertebral artery and phrenic nerve (Figure 5A). Some of the main pathologic processes arising from or involving the PVS contents include: benign and

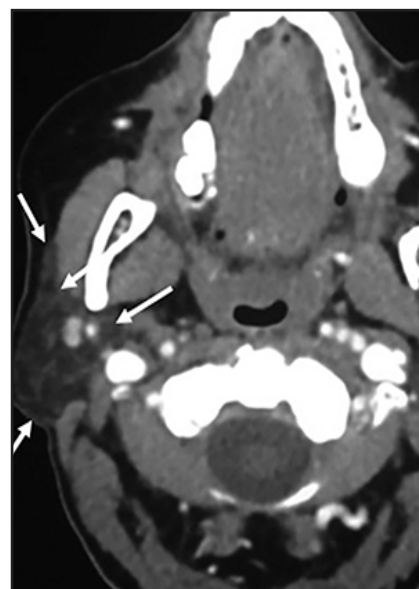
malignant mesenchymal tumors, calcific tendinitis, osteophytes, osteomyelitis, primary bone tumors, metastases, diskitis, anterior disk herniation, aneurysm, lymphoma, and direct extension of carcinoma of the nasopharynx (Figures 5B and 5C).<sup>2,5</sup> The most common PVS malignancy in children is a rhabdomyosarcoma. This tumor can be difficult to differentiate from a neuroblastoma that arises from the sympathetic chain, located in the adjacent carotid space.

### Parapharyngeal space

The parapharyngeal space (PPS), also known as the prestyloid PPS, is next to the pharynx and extends from the skull base to the hyoid bone.<sup>1-4,12</sup> The contents of the PPS includes fat, vascular structures, small branches of the fifth cranial nerve, lymph nodes and ectopic rests of minor salivary gland tissue<sup>1</sup> (Figure 6A). The primary PPS masses usually displace the lateral wall of the visceral space medially, the deep lobe of the



**FIGURE 11.** (A, B.) Axial and coronal T2 and contrast-enhanced MRI images demonstrate an aneurysmal bone cyst arising from the mandibular component of the mandible (arrows).



**FIGURE 12.** The parotid space is outlined by the white arrows.

**Table 4. Anatomically-based differential diagnosis for the parotid space**

- Parenchymal origin: Neoplasms (salivary gland), pleomorphic adenoma, Warthin's tumor, mucoepidermoid carcinoma, adenoid cystic carcinoma, acinous carcinoma, oncocytoma, malignant mixed tumor (Figure 13A).
- Neoplasms (nonsalivary): Lymphangioma, hemangioma, venolymphatic malformation, lipoma (Figures 13B, 13C).
- Infectious/Inflammatory: Parotiditis, parotid abscess, cellulitis, radiation sialadenitis, lymphoepithelial cysts, type 1 and 2 (Figure 13D).
- Miscellaneous: First branchial cleft anomaly.
- Lymph nodes: Metastatic SCC from skin cancer, non-Hodgkin's lymphoma, melanoma
- Facial nerve: Neurogenic tumors, perineural spread of tumor.<sup>1</sup>

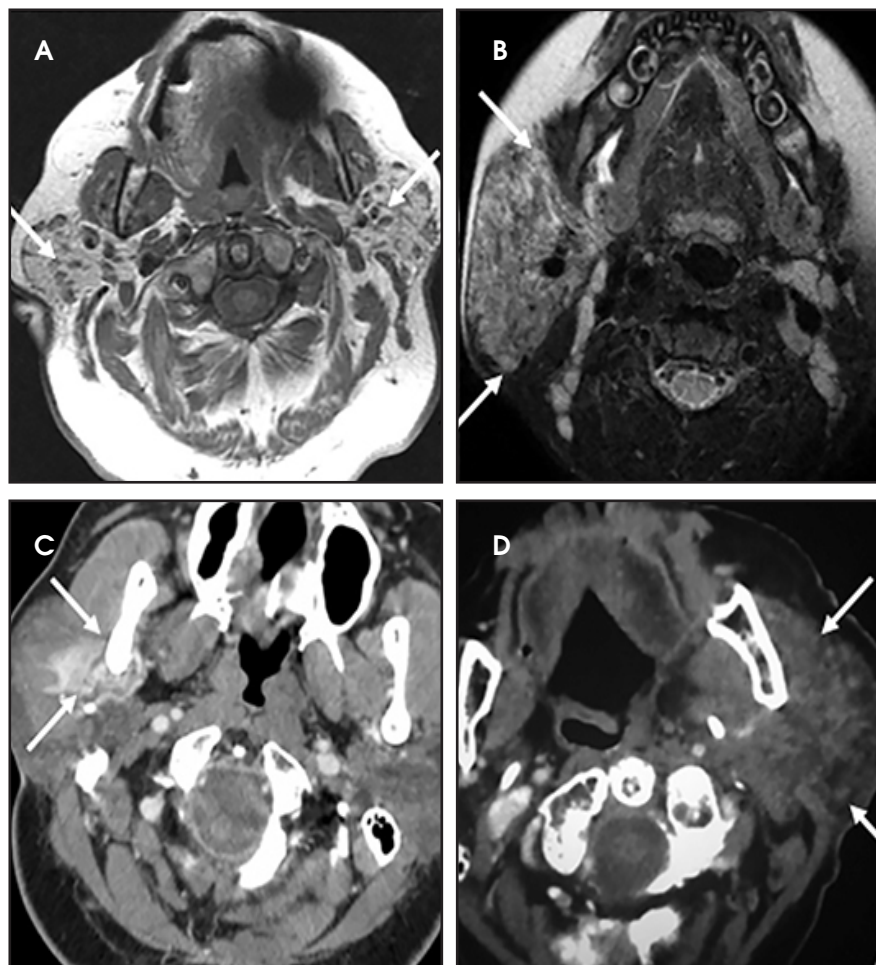
parotid gland laterally, and the contents of the CS posteriorly. It is also important to differentiate a primary PPS mass from a mass arising from the deep lobe of the parotid because nonvascular masses localized to the PPS may be resected via a submandibular cervical approach while a deep parotid lobe mass might require a total parotidectomy.<sup>1</sup>

Some of the primary PPS masses include minor salivary gland tumors arising from ectopic salivary gland tissue rests, atypical type II first branchial cleft anomaly, and lipomas. Secondary PPS masses include deep spread of

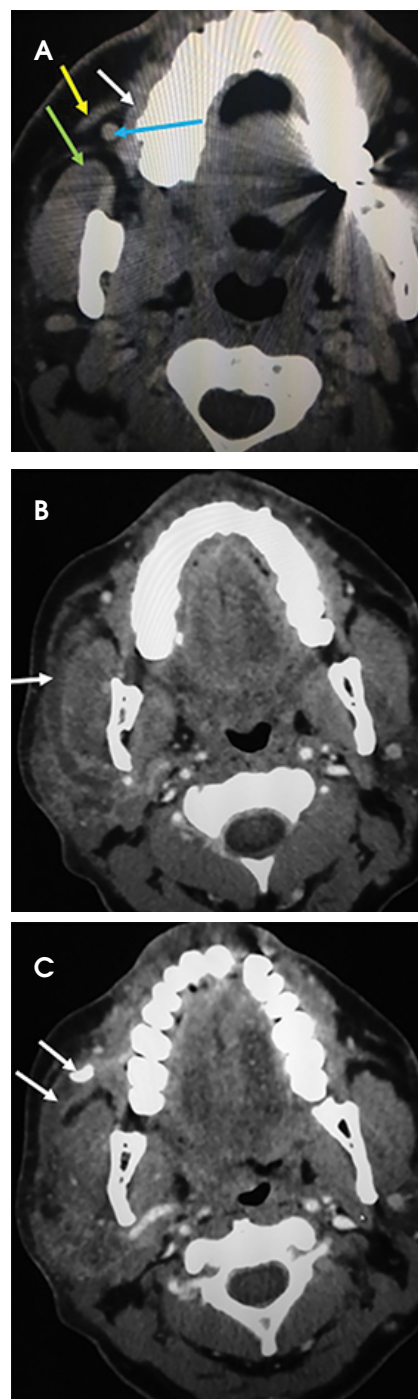
malignant tumor from adjacent spaces, SCC from the visceral space, sarcoma from the MS (masticator space), minor salivary gland tumor from PS or PPS abscess (odontogenic infection from the MS, or tonsil infection).<sup>1</sup> Primary PPS masses are unusual and the most common primary lesion of the PPS is a minor salivary gland tumor (Figure 6B and 6C). The most common lesions in the PPS result from secondary extension of pathologic processes arising from the adjacent spaces and the most pathology is deep extension of SCC arising in the tonsillar region.<sup>1</sup>

### Carotid space

The carotid space, also known as the post styloid PPS or the carotid sheath, is located posterior to the styloid process and lateral to the RPS and PVS.<sup>2,3,9,13</sup> Its sheath extends superiorly to the jugular foramen and inferiorly to the aortic arch and is bordered anteriorly by the styloid process and PPS, laterally by the anterior belly of the digastric muscle and the PS and medially by the lateral margin of the RPS. It contains the internal carotid artery, internal jugular vein, sympathetic chain, cranial nerves IX to XII and lymph nodes (Figure 7A).<sup>1</sup> Most of the



**FIGURE 13.** (A) Multiple small bilateral parotid masses in a patient with Warthin's tumor (arrows). (B) Asymmetric enlargement and high signal with parotid gland in a patient with a hemangioma (arrows). (C) Ill-defined enhancing area in the right parotid gland (venolymphatic malformation). (D) Asymmetric enlargement and inflammation of the left parotid gland consist with parotiditis (arrows).



**FIGURE 14.** (A) The buccal space medially is bordered by the buccinator muscle (white arrow), anteriorly by the superficial muscle of facial expression (yellow arrow), posteriorly by the masticator space (green arrow) and the parotid space laterally. It contains the buccal segment of the parotid duct (green arrow) and the facial vein (blue arrow). (B, C) Axial contrast-enhanced CT scan of the neck demonstrates parotiditis and stone within the buccal segment of the parotid gland (arrows).

pathology involving the carotid sheath are those that originate from the carotid space (Figures 8 and 9). Enlarged lymph nodes are the most common pathology of the carotid sheath (Table 2). In children the most common primary malignancy of the carotid sheath is a neuroblastoma.<sup>1</sup>

### Masticator space

The masticator space (MS) contains muscles of mastication (medial and lateral pterygoid, masseter, and temporalis), ramus of the mandible and the third division of the cranial nerve V (Figure 10A).<sup>1-4,14,15</sup> It extends inferiorly to the attachment of the medial pterygoid and masseter muscles to the mandible and the superomedial margin of the MS at

the skull base. The superomedial margin of the masticator space includes soft tissues inferior to the foramen ovale so any malignancy involving the MS has potential to extend to the cavernous sinus via retrograde perineural spread along cranial nerve V3.<sup>1</sup> The anatomically-based differential diagnosis is referenced in Table 3.

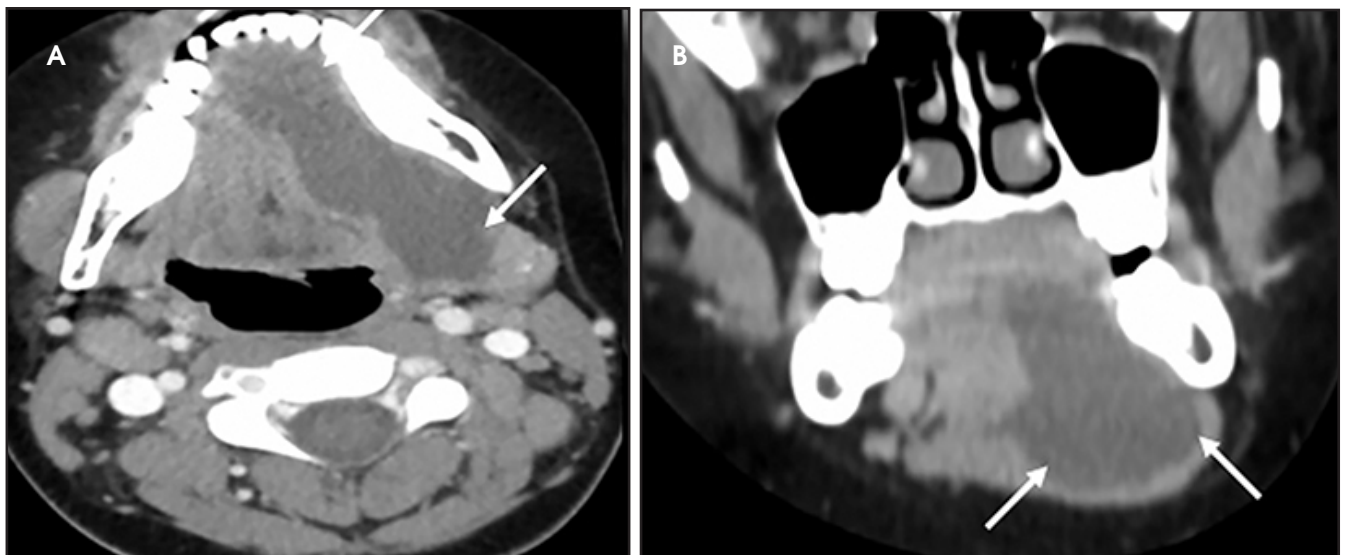
### Parotid space

The parotid space (PS) contains the parotid gland and is divided into superficial and deep lobes by the facial nerve which is located just lateral to the retromandibular vein (Figure 12).<sup>2-4,9,16</sup> The contents include gland parenchyma, facial nerve, retromandibular vein, external carotid artery, and intra parotid lymph nodes. The





**FIGURE 15.** (A) Coronal T2-weighted MRI image illustrates the mylohyoid muscle, which separates the sublingual space and the submandibular space anteriorly. White arrow: mylohyoid muscle. Blue arrow: Anterior belly of digastric muscle. Red arrows: submandibular gland. (B) Extensive edema and multicompartmental abscesses involving both the submandibular and sublingual spaces consistent with Ludwig's angina (arrows). (C) Asymmetric enlargement of the left submandibular duct containing a large stone (arrow) consistent with sialolithiasis.



**FIGURE 16.** (A, B) Axial and coronal contrast-enhanced CT scan of the neck reveals a cystic lesion in the sublingual region with extension into the submandibular space (arrows) consistent with a diving ranula.

anatomically based differential diagnosis is shown in Table 4.

### Buccal space

The buccal space (BS) does not have complete fascial coverings and is bordered medially by the buccinators muscle, MS posteriorly, PS laterally and anteriorly. It is separated from the subcutaneous tissues of the face by the plane formed by the superficial muscle of facial expression and the investing fascia<sup>1</sup> (Figure 14A). The contents of the BS are ad-

ipose tissue, minor salivary gland tissue, parotid duct, lymph nodes, fascial vein, facial and buccal artery, buccal branch of the cranial nerve VII, buccal division of the mandibular division of cranial nerve V. The differential diagnosis for the contents are as follows: SCC (direct extension or nodal metastases), lymphoma, minor salivary gland tumors, lipoma, hemangioma, sarcoma, sebaceous cyst, fibromatosis, obstructed duct, accessory parotid tissue, cellulitis and abscess (Figures 14B and 14C).<sup>1</sup>

### Sublingual space

The sublingual space (SLS), referred to as the floor of mouth, is the space located below the tongue and confined by the mylohyoid muscle and hyoid bone (Figure 15A). The contents of the SLS include muscles, the hypoglossal nerve, the lingual nerve, lingual artery and vein, sublingual gland and ducts, the deep portion of the submandibular gland and duct and lymph nodes.<sup>1</sup> The differential diagnoses for the contents are as follows: SCC from the epithelial lining,



minor salivary gland tumors, ranula, obstructed submandibular duct, abscess, Ludwig's angina, neurogenic tumor, lingual thyroid, thyroglossal duct cyst, hemangioma, lymphangioma, dermoid/epidermoid (Figures 15B and C).<sup>1</sup>

## Submandibular space

The submandibular space (SMS) is located below the mandible, inferior to the mylohyoid muscle and the inferior margin is the hyoid bone (Figure 15A). The posterior portion of the SMS is in direct communication with posterior aspect of the SLS. The contents of the SMS are: anterior belly of the digastric muscle, superficial portion of the submandibular gland, submandibular and submental lymph nodes, facial artery and vein, fat, and the inferior loop of the hypoglossal nerve.<sup>1</sup> The differential diagnoses for the contents are as follows: metastatic disease, lymphoma, adenitis, obstructed submandibular duct, salivary gland tumors, abscess, Ludwig's angina, thyroglossal duct cyst, hemangioma, lymphangioma, dermoid/epidermoid, diving ranula (complex),

second branchial cleft cyst (more common in children) (Figure 16).<sup>1</sup>

## Conclusion

Contrary to popular belief, the spaces of the head and neck were not created to torture residents studying for their boards. Rather, a proper understanding of the anatomical spaces of the neck can aid considerably in formulating a differential diagnosis of pathologic processes involving the contents of that space and providing better care for our patients.

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