"The Space Between Us:" A Radiographic Review of Common and Uncommon Pathologic Findings within the Deep Spaces of the Neck

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Learning objectives

1. Review the various deep spaces of the neck, including anatomy, adjacent structures and contents.

2. Review common and uncommon pathologies within the deep spaces of the neck.

3. Evaluate imaging findings of certain lesions within the deep spaces of the neck.

Background

Head and neck imaging is a complicated yet vital field of radiology, the importance of which is often neglected by radiologists as well as radiology residents. The deep spaces of the neck present a variety of unique oncologic, infectious, congenital, and vascular lesions. An understanding of the anatomy, imaging characteristics and differentials of each particular region are vital in making an accurate diagnosis.

We present a comprehensive review of the deep spaces of the neck and some of the common and rare pathologies that are found within each space. We review the CT and MR pathologic findings within the parotid, pharyngeal mucosal, parapharyngeal, visceral, masticator, perivertebral, carotid, retropharyngeal and danger spaces. We further discuss a case-based review of a variety of pathologic findings within these spaces, including laryngeal squamous cell carcinoma, nasopharyngeal carcinoma, branchial cleft cyst, thornwaldt cyst, Warthin tumor, carotid body tumor, acute calcific longus colli tendinitis, cervical lymphadenitis and multiple abscesses. We also evaluate associated findings, effects onto adjacent structures and extension into multiple spaces.

Findings and procedure details

The deep spaces of the neck are separated into the suprathyoid and infrahyoid neck. The suprathyoid region extends from the base of the skull to the hyoid bone. The suprathyoid spaces include the parapharyngeal space, pharyngeal mucosal space, masticator space, parotid space, carotid space, retropharyngeal space, danger space and perivertebral space. The infrahyoid region extends from the base of the skull to the clavicles. The infrahyoid neck includes the visceral space, carotid space, retropharyngeal space, danger space and the perivertebral space. A variety of unique oncologic, infectious, congenital and vascular lesions are seen within the deep spaces of the neck.
1. **Parotid Space**

The parotid space is mostly filled by the parotid gland and the most lateral space of the upper surpahyoid neck. It extends from the external auditory canal to the angle of the mandible and includes the retromandibular vein, facial nerve and intraparotid lymph nodes. It is located posterior to the masticator space and lateral to the carotid space and parapharyngeal space. [2-3] Some of the major diagnoses that can be found in the parotid space include hemangioma, salivary gland tumour, metastatic adenopathy, lymphoma, parotid cysts, abscess/cellulitis (Figure 1), parotitis, sialadenitis, branchial cleft cyst (Figure 2) and Warthin’s tumor (Figure 3). [3]

2. **Pharyngeal Mucosal Space**

The pharyngeal space includes the tissues on the mucosal surface of the nasopharynx, oropharynx, and hypopharynx. The pharyngeal mucosal space is bounded by the airway, is medial to the parapharyngeal space and anterior to the retropharyngeal space. [4] It extends from the skull base to the cricoid cartilage and includes squamous mucosa, lymphoid tissue, adenoids, tonsils, minor salivary glands and the pharyngeal muscles. [2,5] Pathology that may be seen in this space include nasopharyngeal carcinoma, squamous cell carcinoma (Figure 4), adenoid cystic carcinoma, minor salivary gland tumours, juvenile angiofibrom, Thornwaldt cyst (Figure 5), tonsillitis and tonsillar abscess (Figure 6). [5]

3. **Parapharyngeal Space**

The parapharyngeal space is centrally located within the deep spaces of the neck and contains mostly fat. It is shaped like a pyramid and also contains the trigeminal nerve, internal maxillary artery and ascending pharyngeal artery. The parapharyngeal space is located between the muscles of mastication and the muscles of deglutition. It is medial to the masticator space, lateral to the pharyngeal mucosal space and anterior to the perivertebral space. [2,6] Some of the pathological lesions seen within this space include salivary gland tumours, nasopharyngeal carcinoma (Figure 7), lipoma, parapharyngeal cellulitis, cervical lymphadenitis (Figure 8) and trigeminal schwannoma. [6]

4. **Visceral Space**

The visceral space extends from the hyoid bone down into the mediastinum. The borders of the visceral space include the carotid spaces laterally, the retropharyngeal space posteriorly and the anterior cervix anteriorly. Included in the visceral space are the viscera of the larynx, trachea, hypopharynx, esophagus, and thyroid and parathyroid glands, as well as the recurrent laryngeal nerve, cervical lymph nodes and the infrahyoid strap muscles. [2] Lesions within the visceral space include laryngocele, squamous
cell carcinoma (Figure 9), Zenker's diverticulum, tracheal stenosis, goiter, colloid cyst, thyroiditis, thyroid adenoma, thyroglossal duct cyst, and recurrent nerve paralysis. [7]

5. Masticator Space

The masticator space is located at the lower border of the mandible. It contains two layers of fascia that split with the inner layer running deep to the medial pterygoid muscle and attaching to the skull base and the outer layer covering masseter and temporalis muscles and attaching to the parietal cavarium superiorly. [8] The masticator space is located anterior to the parotid space, anterolateral to the parapharyngeal space, superior to the tongue and mandible and inferior to the skull base. It contains the muscles of mastication, mandibular ramus, the temporomandibular joint, inferior alveolar vein and artery and the mandibular division of the trigeminal nerve (V3). [2] Pathologies that can be found in this space include odontogenic abscess, osteomyelitis, squamous cell carcinoma, maxillary sinus tumor (Figure 10), lymphoma, sarcoma, sarcoma, schwannoma and neurofibroma. [8]

6. Perivertebral Space

The perivertebral space is located midline, around the spine and extends from the skull base to the coccyx. The perivertebral space is separated into the prevertebral and paraspinal spaces. The prevertebral space is bounded posteriorly by the vertebral bodies, anteriorly by the retropharyngeal and danger space and laterally by the carotid space. The posterior spinal space is deep to the transverse processes of the cervical spine. [2] The prevertebral portion of the perivertebral space contains cervical vertebral body and disc, prevertebral muscles, scalene muscles, vertebral artery and vein, phrenic nerve, and brachial plexus. The paraspinal portion contains the posterior elements of cervical vertebrae and the paraspinal muscles. Some of the pathologies that may be found in the perivertebral space includes abscess, osseous metastases, chordoma, osteomyelitis, schwannoma, chondromas, squamous cell carcinoma, anterior herniated disc, vertebral osteophytes and acute calcific longus colli tendonitis (Figure 11). [9]

7. Carotid Space

The carotid space is enclosed by the carotid sheath and adjacent to the parapharyngeal space. It is bordered by the retropharyngeal space medially, visceral space anteromedially, parapharyngeal space anteriorly, parotid space laterally, aortic arch inferiorly and the prevertebral space posteromedially. [2] The carotid space contains the common carotid artery, internal carotid artery, internal jugular vein, glossopharyngeal nerve, vagus nerve, accessory nerve, hypoglossal nerve, sympathetic nerves and deep cervical lymph nodes. Pathologic lesions that can be seen in the carotid space include vascular pseudotumours
vascular lesions, arterial or venous thrombosis, internal jugular vein thrombophlebitis, carotid artery dissection or aneurysm, cellulitis/abscess, schwannoma, neurofibroma, carotid body paraganglioma (Figure 12), meningioma and lymphoma. [10]

8. Retropharyngeal Space

The retropharyngeal is located midline in the posterior pharynx and consists mostly of fat and lymph nodes. It extends from the base of the skull to the upper thoracic level. The retropharyngeal space is located anterior to the danger space, posterior to the pharyngeal mucosal space, anteromedial to the carotid space and posteromedial to the parapharyngeal space. [11] The pathologies that are found in the retropharyngeal space include retropharyngeal abscess (Figure 13), metastatic adenopathy, adenitis, lipoma, hemangioma, squamous cell carcinoma and lymphoma. [2]

9. Danger Space

The danger space is a potential space that contains fat and is located posterior to the retropharyngeal space and anterior to the perivertebral space. It extends from the skull base to the diaphragm. It has potential for the rapid extent of infection down to the mediastinum. Pathology that can be seen in this space include abscess, fluid or emphysema (Figure 14). [2,12]

Images for this section:
Contrast-enhanced CT of the soft tissues of the neck on this 21 month old male with two week history of neck swelling shows a right parotid abscess with adjacent cellulitis.
Parotid Space: Branchial Cleft Cyst

16 year old male with CT of the neck showing a large simple cystic lesion in the right parotid to right parapharyngeal spaces, consistent with a branchial cleft cyst.

Fig. 2
Parotid Space: Warthin’s Tumor

CT of the soft tissues of the neck showing a septated cystic lesion containing a mural nodule within the left parotid gland, consistent with Warthin's tumor (adenolymphoma).

Fig. 3
81 year old male with large exophytic oropharyngeal and hypopharyngeal soft tissue mass. On pathology, the mass was found to be spindle cell carcinoma, a rare variant of squamous cell carcinoma.

Fig. 4
Fig. 5

MRI Brain performed for headache with incidental finding of a 5 mm cystic structure in the posterior nasopharynx consistent with a Thornwaldt cyst.
Pharyngeal Mucosal Space: Tonsillar Abscess

CT of the neck of a 21 year old female with 3 cm peripherally enhancing centrally cystic/necrotic lesion in the left tonsil consistent with a tonsillar abscess.

Fig. 6
Parapharyngeal Space: Nasopharyngeal Carcinoma

16 year old male MRI of the neck showing nasopharyngeal carcinoma with parapharyngeal extension vs nodal metastases and adjacent posterior cervical chain metastases.

Fig. 7
Parapharyngeal Space: Cervical Lymphadenitis

24 year old male with left neck swelling with CT of the neck performed for left neck swelling. Multiple conglomerate centrally cystic or necrotic lymph nodes in the left side of the neck involving the parapharyngeal space, consistent with cervical lymphadenitis.

Fig. 8
Visceral Space: Laryngeal Carcinoma

Contrast-enhanced CT of the soft tissues of the neck showing 80 year old male with laryngeal carcinoma. This was pathology proven to be squamous cell carcinoma.

Fig. 9
76 year old female with neck CT and brain MRI showing a destructive mass lesion filling the right maxillary sinus and extending into the adjacent soft tissues, right infratemporal fossa, and right masticator space. There is involvement of the pterygoid musculature.
Perivertebral Space: Acute Calcific Longus Colli Tendinitis

60 year old female being evaluated for retropharyngeal abscess with CT and MRI showing abnormal calcification at the C2 level within the prevertebral region and abnormal edema within the retropharyngeal space. Findings are compatible with acute calcific longus colli tendinitis.

Fig. 11
41 year old female with CT of the neck showing a heterogeneously enhancing mass at the right common carotid artery bifurcation, compatible with a carotid body paraganglioma.

Fig. 12
CT neck of a 3 year old male status post adenoidectomy with fever, neck pain and limited neck motion. There is a peripherally enhancing low-density collection in the left lateral retropharyngeal space with extension of ill-defined fluid down to the C7 level. Findings are consistent with retropharyngeal abscess/phlegmon.

Fig. 13
CT of the neck in a 16 year old male showing an extremely large and extensive retropharyngeal gas and fluid collection extending from the skull base caudally to the visualized upper mediastinum, with extension into the danger space and carotid space. The patient had extensive retropharyngeal emphysema and fluid from esophageal rupture.
Conclusion

Pathologic findings within the deep spaces of the neck present unique radiographic features and result in a complicated constellation of findings. We reviewed common and uncommon pathologies seen within the deep spaces of the neck. The radiologist’s role in accurate diagnosis of these lesions and understanding of their manifestation plays a crucial role in patient care and management.

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References


