Anatomy and common pathology of the parapharyngeal space: The imaging challenges

Poster No.: C-0965
Congress: ECR 2015
Type: Educational Exhibit
Keywords: Anatomy, Head and neck, CT, MR, Diagnostic procedure, Pathology, Neoplasia, Infection
DOI: 10.1594/ecr2015/C-0965

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

The current exhibit aims to:

- To illustrate the radiological anatomy of the parapharyngeal space (PPS).
- To demonstrate diagnostic approach of PPS lesions by using CT and MR techniques.
- To describe the imaging features of a variety of disease processes that may occur in the PPS.

Background

The PPS is defined as the deepest space in the neck and it consists of the pre- and post-styloid regions. Due to its critical location and anatomic relationships, it acts as a highway for extension of multitude of lesions to and from this space. The differentiation of a pre-styloid lesion from a post-styloid lesion is essential for the differential diagnosis. Clinical examination is limited by the inaccessible location; hence diagnosis of PPS pathologies is completely dependent on imaging.

Findings and procedure details

I-Anatomy of the PPS:

The parapharyngeal space (PPS) is a fascial space in the suprahylid neck, shaped like an inverted cone and extends from the skull base down to the level both side soft hypopharynx (1,2) (Figure 1).

The superior border (base) is a portion of the temporal bone lateral to the attachment of the pharyngo-basilar fascia and medial to foramen ovale and spinosum. It has 3 bony landmarks: scaphoid fossa -origin of the tensor veli palatine-, spine of the sphenoid bone and styloid process. None of the skull base foramina is included in the roof of the PPS (3,4) (Figure 2).
The inferior border (apex) is described at the junction of the posterior belly of the digastric muscle and greater cornu of the hyoid bone (5). Practically, facial planes and muscle sheaths at the level of the mandibular angle obstruct the space at this level (6).

The medial border is formed by the buccopharyngeal fascia over the pharyngobasilar fascia and the pharyngeal constrictor muscles (3).

The lateral border is formed by the superficial layer of the deep cervical fascia over the masticator space and the deep lobe of the parotid (3). The deep lobe of the parotid gland bulges toward the lateral aspect of the prestyloid PPS through the stylo-mandibular tunnel, anterior to the styloid process and the styloid muscles (6).

The anterior border is usually considered to be the pterygo-mandibular raphe, which is a soft tissue condensation that extends from the hamulus of the medial pterygoid plate to the lingual surface of the mandible, posterior to the myelo-hyoid line (4).

The posterior border is the prevertebral fascia that covers the spinal column and paraspinal muscles (3).

The tensor vascular styloid fascia is a fascial layer that divides the PPS into prestyloid and retrostyloid compartments. It extends between the pterygoid plate, the tensor veli palatini, and the skull base at the level of the styloid process and its associated musculatures (6).

This fascial plane is used as a surgical landmark with the major vessels and cranial nerve laying deep to it.

* Contents of the PPS:

- **The prestyloid PPS** mainly contains fat and connective tissue. Additionally, branches of the internal maxillary artery and veins, branches of cranial nerve V and minor salivary gland rests are present(6).

- **The retrostyloid compartment (carotid space)** contains the carotid sheath with the intranal carotid artery (ICA) and internal jugular vein, cranial nerves IX through XII, sympathetic chain, and lymph nodes (6).

**Il-Radiological anatomy of the PPS:**
Owing to the deep location of the PPS in the neck, lesions may grow considerably in it before causing any symptoms or signs. Radiology has an important role in the diagnosis and treatment planning of such lesions (Figure 3). Which imaging modality to use, either CT or MRI, depends on local factors such as availability and experience and specific differential diagnostic considerations. MRI has the advantage of better tissue characterization and better definition of tumor margins (6) whereas on CT, bony details and landmarks are better seen.

**III- Pathologic entities:**

The vast majority of lesions of the PPS arises in adjacent spaces and spread into it. Imaging is an indispensable tool in the investigation of PPS and its different pathologies. CT and especially MRI exquisitely display the complex anatomy of this region and provide accurate spatial localization of pathology, differential diagnosis and information for treatment planning.

The pictorial review illustrates a wide variety of disease processes including tumoral, vascular, congenital and infectious etiologies.

1-Tumoral lesions:

1-1- Prestyloid PPS lesions:

a) Salivary tumors:

Ø Pleomorphic adenoma:

Pleomorphic adenomas account for 70-80% of benign salivary gland tumours and are especially common in the parotid gland.

As the name suggests pleomorphic adenomas are composed of a mixture of variable histology. They contain both epithelial and myoepithelia (mesenchymal) tissues, with varied histology.

They appear encapsulated and well circumscribed (7), however the pseudocapsule is delicate and incomplete with microscopic extensions reaching beyond it, accounting for the high risk of recurrence when these tumours are enucleated.
They are commonly seen on MRI as well-circumscribed and homogeneous when small. Larger tumours may be heterogeneous.

It appears hypointense on T-weighted images with marked hyperintensity on T2-weighted MR images (Figures 4, 5). Heterogeneous post-contrast enhancement may be seen. Hemorrhage, necrosis and calcifications may occur.

Ø **Adenoid cystic carcinoma:**

Adenoid cystic carcinoma (ACC) is a rare epithelioid head and neck tumor accounting for about 7.5% of all salivary gland malignancies.

Although 5-year survival rates are in general moderate and lymph node metastases are rare, this tumor entity is hard to manage because of its indolent and slow growth associated to frequent late distant metastases and relapse of the tumor origin (8).

It appears hypo- to isointense on T-weighted images, slightly hyperintense on T2-weighted images (higher grades being markedly hyperintense) with homogeneous enhancement.

Ø **Myoepithelioma of a minor salivary gland:**

Myoepithelioma is a rare neoplasm of the salivary glands defined as a generally benign tumour composed of myoepithelial cells, generally occurring in the parotid gland and less often in the minor accessory salivary gland of the oral cavity (9).

Most of tumours were seen as well-defined ovoid masses with low or intermediate signal intensity on T1-weighted images, and inhomogeneous high signal intensity areas on T2-weighted images, whereas inhomogeneous enhancement was seen on post-contrast T1-weighted images (Figures 6, 7).

b) **Lymph node metastases:**

The sites of lymph node metastasis of papillary thyroid carcinomas are typically the paratracheal and jugular lymph nodes. On the other hand, metastasis to the parapharyngeal nodes from papillary thyroid carcinomas is very rare.

Lymph node metastases from papillary thyroid carcinoma might show characteristic imaging features such as a cystic appearance and calcifications (10).
In both CT and MRI, cavitation results in a fluid density/signal intensity (low density, hyperintensity on SE T2, hypointensity on SE T1). As a general rule, thyroid carcinomas have a tendency to produce large amounts of macromolecular colloid material (including thyroglobulin). Moreover, their high vascularization accounts for the onset of spontaneous intralesional hemorrhages. Both the macromolecular protein content and the hemoglobin catabolites shorten the T1 relaxation time, resulting in a spontaneously SE T1 hyperintense signal of the node (Figures 8, 9).

c)- Sarcoma:

Sarcoma of the parapharyngeal space is very rare and may be difficult to diagnose. Different types can occur in PPS (rahabdomyosarcoma, synovial sarcoma, leiomyosarcoma…) (11) (Figures 10).

1-2- Retrostyloid PPS lesions:

a)- Neurogenic tumors:

Ø Paragangliomas:

They represent 10 to 15 % of all the lesions in the PPS, almost all of them originating in the retrostyloid compartment.

Three varieties of paraganglioma are seen in the PPS depending on its site of origin (12). The most common type is glomus vagale paraganglioma (Figure 11), originating from the glomus bodies, located in nodose ganglion of vagus nerve, just 1 to 2 cm below jugular foramen. Second common type is the carotid body tumor (Figure 12) which originates from the carotid body cells near the carotid bifurcation. They cause characteristic splaying of internal carotid artery (ICA) and external carotid artery (ECA) when located in the crux of carotid bifurcation. Third type is glomus jugulare tumors which arise from the paraganglionic cells around the jugular ganglion.

On T2-xeighted sequence, a characteristic ‘salt and pepper’ appearance is noted. Dynamic contrast enhanced MRI shows a hypervascular curve with a sharp early filling peak and a rapid washout phase.

Ø Schwannoma:
Schwannoma is an uncommon benign neurogenic tumour arising from Schwann cells or supporting fibroblast of peripheral, cranial or autonomic nerves.

Schwannomas are usually ovoid or fusiform masses with well-delineated margins and are higher in attenuation than adjacent muscle or isodense, less commonly of lower attenuation than the adjacent muscle.

These schwannomas show typical anteromedial displacement of the internal carotid artery and lateral displacement with compression of the internal jugular vein.

On MRI, they appear heterogeneously hyperintense on T2-weighted images and isointense to hypointense on T1-weighted images (13). No flow-voids are noted within them, which help to differentiate it from paraganglioma.

2- Congenital lesions:

2-1- Branchial cysts:

Branchial cysts may arise in the PPS. They originate in the second branchial apparatus most likely from the branchial pouch. These cysts are located deep to the tonsillar fossa in the medial aspect of the PPS and just anterior to retropharyngeal space.

On CT, they are seen as low attenuation lesions (10-20 HU) with thin uniformly smooth wall. On MR imaging, they appear as T1-weighted hypointense and T2-weighted hyperintense lesions with peripheral enhancement on post-contrast study. When a cyst is infected, the density of its content increases and shows increased attenuation on CT and the wall thickens and enhances (12).

2-2- Teratomas:

Teratomas may rarely occur in the PPS and most have occurred in newborns and infants. Components of all three germ layers are present. On CT, areas of calcification, ossification, fat and cystic degeneration can be seen within a heterogeneously enhancing mass lesion (14).

3- Infectious or Inflammatory Lesions:
Most commonly, infections of the masticator space involve the parapharyngeal space and accompany medial displacement of the parapharyngeal space fat. Obliteration of the parapharyngeal space fat plane is also frequently associated with infections of the masticator space. Odontogenic infection is most commonly the source of an inflammatory mass in the masticator space and is frequently associated with facial swelling, pain, and trismus (15).

The pharyngeal tonsil and submandibular gland can be another source of infection involving the parapharyngeal space. Cellulitis or abscess may form as a complication of acute tonsillitis or sialoadenitis.

On the contrary, infections may readily spread from the parapharyngeal space into other areas of the neck (Figure 13), or extend via the retropharyngeal space into the upper mediastinum because of the parapharyngeal space's close attachment and free communication with the other neck spaces (16).

4- Vascular anomalies:

4-1- Aneurysm:

Aneurysms arising from carotid artery, most commonly occur at bifurcation (Figure 14). The presence of characteristic peripheral rim calcification with non visualization of internal carotid artery (ICA) separately is adequate for identification of aneurysm (12). Further confirmation with MRA and CTA can be made.

4-2- ICA dissection:

ICA dissection is seen as narrowing of arterial lumen with eccentric mural thickening. CT will also show hypodense intramural hematoma with enhancing rim of vasa vasorum. On MRI, intramural hematoma appears hyperintense on both T1-weighted and T2-weighted images. Fat suppressed T1-weighted is the single best MRI sequence for diagnosis of dissection (17).

4-3- Variations of ICA:

Variations in the course of ICA may occur, commonly as a result of atherosclerosis (18). Close proximity of ICA to pharyngeal tonsils should be reported, as it may increase the surgical risk.
Congenital variant of ICA with sigmoid shaped tortuosity can cause bulging of pharyngeal mucosal space, simulating a parapharyngeal or retropharyngeal mass.

These variations can be easily identified on contrast enhanced CT or MRI.

**Images for this section:**

![Fig. 1: The PPS as an inverted cone that extends from the skull base to the mandibular angle.](image)

**Fig. 1:** The PPS as an inverted cone that extends from the skull base to the mandibular angle.
Fig. 2: The axial plane showing the PPS and adjacent neck spaces
Fig. 3: Normal anatomy of parapharyngeal space. BS = buccal space, ICA = internal carotid artery, IJV = internal jugular vein, MS = masticator space, PMS = pharyngeal mucosal space, PPS = parapharyngeal space, PVS = pre-vertebral space, SMS = submandibular space, T = torus tubarius. (References: Shin et al.). Figure 3a: Axial unenhanced T1-weighted spin-echo MR image obtained at nasopharynx level, shows fat-filled prestyloid parapharyngeal space (asterisks) located between masticator space and pharyngeal mucosal space. Torus tubarius represents pharyngeal mucosal space at nasopharynx level. Poststyloid parapharyngeal space containing major neurovascular bundle of internal carotid artery and internal jugular vein is located posteriorly. Figure 3b: Axial unenhanced T1-weighted spin-echo MR image obtained at oropharynx level, shows that parotid space containing parotid gland forms posterolateral boundary of parapharyngeal space (asterisks), and retropharyngeal space and prevertebral space form posteromedial boundary of parapharyngeal space (asterisks). Figure 3c: Coronal unenhanced T1-weighted spin-echo MR image shows continuity of prestyloid parapharyngeal space (asterisks) with submandibular space. Pharyngeal mucosal space is located medially.
Fig. 4: Pleomorphic adenoma of the right parotid gland in 52-year-old woman with dysphagia. Cervical MRI: (A) Axial unenhanced T1-weighted image, (B) Axial T2-weighted image (C), Coronal T2-weighted image show a low-signal-intensity mass on T1 with greater and heterogeneous signal on T2 in the deep lobe of the parotid with displacement of the right-sided PPS fat by the mass (green arrow).
Fig. 5: Minor salivary gland tumor. Cervical MRI: (A) Axial T1-weighted image and (B) Sagittal T1-weighted image show an oval mass in prestyloid compartment of the left parapharyngeal space. Histopathology revealed a pleomorphic adenoma of minor salivary gland.
Fig. 6: Myoepithelioma of a minor salivary gland in 22-year-old man with left submandibular mass. Contrast-enhanced CT scan: (A) Axial, (B) coronal, (C) sagittal, show inhomogeneously enhancing mass in left prestyloid parapharyngeal space. Cervical MRI: (D) Axial unenhanced T1-weighted image, (E) Axial T2-weighted image, (F) coronal T2-weighted image, show a lobulated mass with low-signal-intensity on T1 and high signal-intensity on T2 at the angle of the mandible and which extends into the submandible and sublingual spaces.
Fig. 7: Another case of myoepithelioma of a minor salivary gland from another patient. Cervical MRI: (A) Axial unenhanced T1-weighted image, (B) Axial T2-weighted image, (C) axial contrast-enhanced fat-saturated T1-weighted image, show ovoid masse in left prestyloid parapharyngeal space with low signal on T1W image, and inhomogeneous high signal intensity on T2W image, with intense enhancement on post-contrast T1-weighted image.
Fig. 8: Metastatic lymph node in 36-year-old woman with cervical mass. Ultrasound image demonstrates heterogeneous, hypoechoic oval mass (a), with increased vascularity (b).
Fig. 9: Metastatic lymph node in the same patient. Cervical MRI: (a) Axial T1-weighted image, (b) Axial contrast-enhanced fat-saturated T1-weighted image, (c) Coronal fat-saturated T2-weighted image, (d) MRA: show left-sided lobulated mass with slightly hyperintense signal on T1-weighted image, hyperintense on T2-weighted image, with intense contrast enhancement. It surrounds the internal carotid artery and invades the internal jugular vein. The ARM shows displacement of the internal carotid artery which remains permeable. Histopathology: Lymph node metastasis of a thyroid papillary carcinoma.
**Fig. 10:** Leiomyosarcoma in 50-year-old man with left cervical mass. Cervical MRI: (a, b) Axial unenhanced T1-weighted images show low-signal-intensity mass involving left masticator, parotid and parapharyngeal spaces. Mandible was partially destroyed by tumour.
**Fig. 11:** Glomus vagale paraganglioma: A 40-year-old woman with pulsatile tinnitus. (A) Contrast enhanced CT image shows an enhancing mass occupying the right retrostyloid parapharyngeal space. Cervical MRI: (B) Axial and (C) coronal fat saturated T2-weighted images show an elongated mass at the skull base extending from the jugular foramen to retrostyloid parapharyngeal space displacing the internal carotid artery anteriorly. The tumour is hyperintense on T2-weighted images with "salt and pepper" appearance.
Fig. 12: Carotid paraganglioma: A 52-year-old woman with a right-sided carotid body tumour. Cervical MRI: (A) Axial fat saturated T2-weighted images, (B) Axial contrast-enhanced fat-saturated T1-weighted images, (C) Coronal T1-weighted images, (D) Coronal T2-weighted images, (E, F) Coronal and Sagittal contrast-enhanced fat-saturated T1-weighted images: right latero-cervical mass, isointense to surrounding muscle on T1 with a greater signal intensity than muscle on T2, attached to the carotid bifurcation, splaying the internal and external carotid arteries and enhancing intensively after injection of contrast. This tumour arrives in contact with the submandibular gland and displaces laterally the sterno-cleido-mastoid muscle.
Fig. 13: Abscess: A 45-year-old woman with a left-sided fever and jaw pain. Cervical MRI: (A) Axial and (B) coronal T2-weighted images, (C) coronal fat-saturated T1-weighted images, (C) Coronal T1-weighted images, (D) axial contrast-enhanced fat-saturated T1-weighted images: Collection in left prestyloid parapharyngeal space with central necrosis (which appears with hyperintense signal on T1-weighted image, hyperintense signal on T2-weighted image) and peripheral enhancement.
Fig. 14: Aneurysm of the extracranial internal carotid artery: A 28-year-old man with a pulsatile left-sided mass. Cervical MRI: (A) Axial T1-weighted images, (B) Axial T2-weighted images, (C) axial and (D) coronal contrast-enhanced fat-saturated T1-weighted images, show aneurysmal dilatation beside the left carotid bulb widening the carotid bifurcation.
Conclusion

A clear understanding of the anatomy of the PPS is crucial for an accurate diagnostic approach of pathology arising in this region. The pattern of displacement of fat in the PPS in combination with the imaging characteristics of the mass helps to localize the site of origin of the lesion and to narrow the differential diagnosis.

Personal information

References


