The parapharyngeal space: Review of the anatomy and pathologic conditions.

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Learning objectives

1. To review the anatomy of parapharyngeal space (PPS), as well as the imaging features of the pathologic conditions that can be found in these space.

2. Recognize some forms of displacement of PPS fat that are essential for accurate diagnosis and appropriate treatment of pathology arising in this region.

3. Know the different differential diagnostics of PPS lesions and their imaging features.
Background

The PPS is centrally located and surrounded by other neck spaces from all sides.

The importance of the PPS lies in its relationship with the other spaces of the neck. The masticator and parotid spaces are located laterally, the pharyngeal mucosal space is located medially, and the retropharyngeal space is located posteromedially. The fascia from the styloid process to the tensor veli palatini divides the PPS into an anteromedial compartment (prestyloid) and a posterolateral (poststyloid) compartment. The contents of each compartment are crucial for a correct diagnosis.
Findings and procedure details

Anatomy of the PPS Fig. 1 on page 11

The PPS extends as an inverted pyramid from the base of the skull superiorly, to the hyoid bone inferiorly. The PPS is surrounded by four key spaces (PMS, RPS, MS, PS) of the suprahyoid neck (SHN).

Anatomic boundaries of the PPS:

- **Superior:** The temporal bone lateral to the attachment of the pharyngobasilar fascia and medial to the foramen ovale and foramen spinosum. None of the skull base foramina open within the boundaries of the PPS.

- **Inferior:** The greater cornu of hyoid bone and the posterior belly of the digastric muscle. The PPS is continuous with the posterior aspect of the submandibular space (SMS) at this level.

- **Medial:** The buccopharyngeal fascia which covers the pharyngobasilar fascia and constrictor muscles. The PMS lies medial to the PPS and the RPS lies posteromedial to the PPS.

- **Lateral:** The fascia overlying the pterygoid muscles (MS) and the sphenomandibular ligament. The PPS communicates laterally with the PS through the stylomandibular tunnel.

- **Anterior:** The pterygomandibular raphae which extends from the medial pterygoid plate to the mylohyoid line on the lingual surface of the mandible.

- **Posterior:** The tensor-vascular-styloid fascia (TVS) overlying the tensor veli palatini (TVP) muscle extends from the medial pterygoid plate to the styloid process. It subdivides the PPS into the prestyloid and retrostyloid compartments. Some authors describe the retrostyloid PPS separately as the carotid space.

Compartments: PPS is divided into two compartments: Prestyloid and poststyloid, separated by the styloid process, tensor veli palatini muscle and its fascia.

*Prestyloid PPS*
Patients typically present with a mass in the lateral oropharynx, displacing the tonsil medially.

The pre-styloid PPS is bordered anterolaterally by the medial pterygoid muscle, and posterolaterally by the deep lobe of the parotid gland. It extends from the hyoid bone inferiorly, to the skull base superiorly and contains mainly fat.

Contains: fat, the internal maxillary and ascending pharyngeal artery, pterygoid venous plexus and may contain ectopic salivary gland tissue.

**Poststyloid PPS**

Patients typically present with a mass extending into the upper lateral neck in the lateral oro- or nasopharynx, or with dysfunction of cranial nerves IX-XII, or Horner’ syndrome.

The poststyloid PPS is confined medially by the pharyngobasilar fascia above, and the superior constrictor muscle of the pharynx. It contains the internal carotid artery and the internal jugular vein, as well as the lower cranial nerves IX -XII, and the sympathetic trunk. Unlike pre-styloid masses, poststyloid tumours typically displace the PPS fat anterolaterally.

The most commonly encountered masses include carotid body tumours, or other paragangliomas eg of the vagus nerve and sympathetic trunk, and schwannomas.

Contains: the internal carotid artery (ICA), internal jugular vein (IJV), cranial nerves IX-X-XI-XII and the sympathetic plexus. Lymph nodes of the deep cervical chain are found only below the level of the posterior belly of the digastric muscle.

**Radiological anatomy of the PPS** [Fig. 2 on page 11]

The fat-filled PPS is well appreciated on both axial and coronal CT and MR images. The PPS appears hypodense with fat attenuation on CT images and hyperintense on T1W MR images. In normal circumstances, the PPS should look symmetrical on both sides.

MRI is often preferred over CT in the evaluation of PPS pathology because of its superior contrast resolution.

In the axial plane, the pre-styloid PPS is seen as a triangular fat-filled space widest at the level of the soft palate. The pharyngobasilar may be seen on MRI as a hypointense line outlining the pharyngeal mucosa.
The TVS cannot be routinely identified on MRI. Its course can be traced by drawing an imaginary line from the TVP muscle upto the styloid process.

The lateral fascial border of the PPS is not identifiable on MRI. Its cranial attachment lies just medial to the foramen ovale and the exiting mandibular nerve.

The ICA and IJV appear as flow voids on T1W and T2W MR images, just medial to the styloid process.

**Clinical and diagnostic approach to PPS lesions:**

Since the PPS has relatively few internal structures, primary lesions of the PPS are rare. The PPS is more commonly displaced or infiltrated by lesions arising in the surrounding spaces.

Small tumours of the PPS may be incidental findings whereas large tumors may cause dysphagia, ear fullness, jaw pain and cranial nerve palsy. The deep location of these tumours may hinder their clinical evaluation and may lead to delay in diagnosis. Large lesions may cause internal bulging of the naso/oro-pharyngeal wall or swelling in the parotid region or in the submandibular region.

The clinician as well as the radiologist must be aware of the fact that the cranio-caudal extent of the PPS can make it function as an 'elevator shaft' through which infection or tumour from adjacent spaces can spread to the skull base.

**Displacement patterns of PPS fat Fig. 3 on page 12**

The PPS is surrounded by four key spaces (PMS, RPS, MS, PS) of the suprahyoid neck (SHN). The direction of displacement of the PPS by a mass lesion arising from a surrounding space can be a key finding in determining its space of origin.

PS mass lesion pushes PPS anteromedially.

MS mass lesion pushes PPS posteromedially.

PMS mass lesion pushes PPS laterally.

Lateral RPS mass pushes PPS anterolaterally.
Retrostyloid PPS mass pushes prestyloid PPS anteriorly.

**Pathology of PPS**

PPS is one of potential facial planes of head and neck that may become involved by various pathological processes: infectious, inflammatory, and neoplastic. Neoplastic tumours seen at the PPS represent less than 1% of all head and neck tumours. Both benign and malignant tumors may arise from any structure contained within the PPS where 70-80% appears to be benign and 20-30% appears to be malignant. Most of the tumors arising from the posterior compartment are of neurogenic origin while salivary gland tumours are predisposing the anterior compartment.

Most PPS tumors are of salivary gland tumors, neurogenic tumors especially Schwannomas and paragangliomas, and lymphoreticular lesions which comprise nearly 80% of PPS tumors. The most common tumors arising in the PPS are of salivary gland origin, which account for 40-50% of PPS lesions and are located in the prestyloid PPS. These tumors may originate either in deep lobe of parotid gland, in ectopic salivary gland nests, or in minor salivary glands of the lateral pharyngeal wall. The most common prestyloid PPS lesion is "pleomorphic adenoma," which represents 80-90% of salivary neoplasms in the PPS.

**Pre-styloid PPS lesions**

1) Salivary gland tumours:

These constitute the majority of neoplasms in the prestyloid PPS. These tumours arise from ectopic salivary gland rests in the prestyloid PPS.

However, more commonly they extend from the deep lobe of the parotid and extend exophytically into the PPS.

Pleomorphic adenoma/benign mixed tumour (FIG 4) is the commonest salivary gland tumour. Malignant tumour like mucoepidermoid carcinoma and adenoid cystic carcinoma are uncommon. A tumour is considered to be primary to the PPS if it is completely surrounded by PPS fat. A deep parotid lobe tumour often appears dumbbell-shaped. It is connected to the deep lobe of the parotid gland and is seen to widen the stylomandibulartunnel. It pushes the PPS fat anteromedially. Pleomorphic adenoma usually appears as a well-circumscribed, heterogeneous mass on CT. On MRI, it appears hypointense on T1W images with marked hyperintensity on T2W MR images.
Heterogeneous post contrast enhancement may be seen. Haemorrhage, necrosis and calcifications may occur. Complete surgical removal is the treatment of choice for a pleomorphic adenoma in view of high tendency for recurrence and the less common but likely possibility of malignant conversion (malignant mixed tumour).

2) Lipomas (FIG 5):

Primary lipomas of the PPS are rare and liposarcomas rarer still. Some of lipomas may arise from the parotid space and extend into the PPS.

Lipomas usually appear as well-circumscribed lesions within the prestyloid PPS. Large lipomas may cause internal bulging of the lateral pharyngeal wall. They show fat attenuation on CT and hyperintense signal on TIW MR images. Focal enhancement within a lipoma is suspicious for malignancy ie liposarcoma.

3) Branchial cleft cyst:

The prestyloid PPS is a likely but rare location for an atypical 2nd branchial cleft cyst (BCC). An uncomplicated BCC usually appears well circumscribed with thin walls and fluid contents on CT and MRI. Thickened irregular walls may be due to infection.

In the absence of infection, an atypical cystic lesion in the PPS may be suspicious for metastatic necrotic adenopathy from papillary carcinoma of the thyroid or squamous cell carcinoma of the pharyngeal mucosal space.

Post-styloid PPS lesions:

1) Neurogenic tumours:

Neurogenic tumours (schwannomas and neurofibromas) are the most common primary tumours of the retrostyloid PPS. Retrostyloid tumours typically displace the styloid process anteriorly, ICA anteromedially and the prestyloid PPS anteriorly.

Schwannomas commonly arise from the vagus nerve. CT shows a hypodense fusiform, well-circumscribed mass with mild homogeneous enhancement. Schwannomas often appear hyperintense on T2W MR images. Heterogeneous signal on T1W and T2W images may be due to cystic degeneration or intralesional haemorrhage. Schwannomas
are relatively hypovascular lesions (which often helps to differentiate them from paragangliomas). Malignant transformation is rare.

The imaging features of a solitary neurofibroma overlap those of a schwannoma. Neurofibromas tend to be more hypodense on CT and less enhanced as compared to schwannomas on post contrast CT and MR images. Neurofibromas may show the classical 'target-sign' on axial T2W.

2) Paragangliomas:(FIG 6)

Paragangliomas/ glomus tumours in the head and neck arise from chemoreceptor cells located at three sites; at the nodose ganglion of the vagus at the skull base (vagal paraganglioma), at the carotid bifurcation (carotid paraganglioma/ carotid body tumour) and at the level of the jugular foramen (jugular paraganglioma).

Glomus tumours are typically hypervascular and show marked post contrast enhancement on both CT and MRI. A 'salt-pepper' appearance is common on T1W MR images due to focal areas of haemorrhage and tortuous vessels causing flow voids. Carotid body tumours typically splay the internal and external carotid artery (ECA) away from each other.

Conventional angiography helps to confirm the diagnosis and may be required for pre-operative embolisation

**Secondary lesions of the PPS:**

• The PPS is often secondarily involved by tumour and infection arising in the PMS, MS and PS. Aggressive masticator space neoplasms like sarcomas and PMS neoplasms like squamous cell carcinomas and lymphomas readily infiltrate the PPS.(FIG 8-11 and FIG 15-17)

• Secondary involvement of the PPS is often seen in benign multicompartamental lesions like lymphangioma and hemangioma.

• Parapharyngeal abscess is rare in the modern era of effective antibiotics. The most common scenario is post acute tonsillitis with extension of a peritonsillar abscess through the buccopharyngeal fascia into the PPS (FIG 12-14)

The exact extension of the abscess into the adjacent spaces must be described so as to guide effective drainage.

**Key Diagnostic Information**
One should determine the following before embarking on surgery:

- **Benign / malignant**: This is generally determined by FNAC. The needle biopsy may be done transcervically or transorally, and one should not be concerned about puncturing the internal carotid artery with a small needle.

- **Vascularity**: A paraganglioma may be suspected on CT or MRI, and confirmed angiographically. Vascular tumours may require preoperative embolisation, and proximal vascular control, or one may elect to treat it with radiation therapy.

- **Prestyloid / poststyloid**: This is determined clinically and radiologically with CT / MRI as indicated previously. This information permits narrowing down of the differential diagnosis, planning the best surgical approach, and preoperative counselling of possible sequelae.
Axial schematic nasopharynx level show that parapharyngeal space is divided into prestyloid (yellow low) and poststyloid (bright yellow) compartment by tensor-vascular-styloid fascia (green line) connecting tensor veli palatini muscle with styloid process.

**Fig. 1**

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A) Radiological anatomy of parapharyngeal space is divided into prestyloid (yellow low) and poststyloid (pink) compartment by tensor -vascular-styloid fascia (green line) connecting tensor velli palatini muscle with styloid process (brown).
B) An inverted pyramid-shaped along the pharynx on either side extending from skull base up to the level of angle mandible (marked by the yellow line).

Fig. 2

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Fig. 3

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Fig. 4

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**Fig. 5**

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VASCULARITY LESIONS

Fig. 6

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**Fig. 7**

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Paraganglioma in 42 year-old man with right submandibular area swelling.

(A) Heterogeneous enhancing mass within the right carotid space that extending superiorly. Asimetric obliteration of right fat PPS and anteromedial displacement of ICA (green arrow). The styloid processes are indicated by red arrow (B and C).
Fig. 8

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**Fig. 9**

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Fig. 10

Malignant peripheral nerve sheath tumor arising from trigeminal nerve an facial nerve in 57 year-old man with Parotid neoplasm with right tinnitus, hearing disturbance and facial paresis. 
A,B) CT for ears with soft tissue mass within the right facial nerve canal and right foramen ovale suggesting its perineural extension.
D) Shows tumor is slightly hyperintense to muscle (asterisk)
C,E) Axial and coronal enhanced T1W fat sat shows tumor extends into the eustachian tube, foramen ovale and prestyloid PPS (red arrow)
Fig. 11

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Fig. 12

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Fig. 14

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NEOPLASTIC LESIONS

73-year-old woman with known low-grade lymphoma and swelling at the angle of the mandible.

A,B,D) Axial contrast-enhanced CT was observed hyperdense mass in the right parotid gland and oropharynx with infiltration of PPS (pre and post-styloid compartem) and carotid space.

C) Coronal contrast-enhanced CT reformation show great extension of the lesion affecting PS, PPS, PMS and CS.

Fig. 15

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Fig. 16

71 year-old man with metastatic squamous carcinoma of the tongue.

C) Mass of irregular peripheral enhancement with central hypodense (asterisk) extending along the floor of the mouth posteriorly to infiltrate to the left PPS, PMS, PS, CS, skin and subcutaneous cellular tissue. (PPS: Parapharyngeal space, PMS: Pharyngeal mucosa space, MS: Masticator space, PS: Parotid space)

The styloid processes are indicated by red arrow (A).
Fig. 17

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Conclusion

Clinical examination of PPS lesions is limited by its inaccessible location; hence the diagnosis is completely dependent on imaging studies; CT and MRI could provide the critical information, which were important to operation schemes.
References