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Retropharyngeal and Prevertebral Spaces:

Anatomic Imaging and Diagnosis

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INTRODUCTION

The retropharyngeal space (RPS) extends from the skull base to the upper mediastinum, and the prevertebral space (PVS) extends from the skull base to the coccyx. Diseases of these spaces are uncommon but can result in significant morbidity. As these lesions are inaccessible to clinical inspection,^{1,2} cross-sectional imaging plays an important role in the evaluation of the RPS and PVS and consists of various modalities. Diseases in the RPS and PVS include primary tumors, direct spread of tumors from adjacent spaces, metastasis, congenital/developmental lesions, inflammation, and infection (Table 1).

IMAGING TECHNIQUES

The RPS and PVS can be evaluated by plain radiography, fluoroscopy, multidetector computed tomography (MDCT), magnetic resonance imaging (MRI), ultrasonography, and positron emission tomography/computed tomography (PET/CT). Plain radiographs have been replaced, for the most part, by the more advanced modalities of MDCT and MRI because these provide a more comprehensive evaluation of the neck.

Plain radiographs obtained in anteroposterior and lateral projections may be used to detect radio-opaque foreign bodies and, in the lateral plane, to assess for thickening of the PVS soft tissues (Fig. 1). On plain radiography, a PVS thickness of less than 6 mm at the level of C3 is considered normal in children³; in adults, a PVS of less than 6 mm at C2 and less than 22 mm at C6 is within normal limits. The differential diagnosis of a widened PVS includes edema, hematoma, abscess, tumors, and surgical reconstruction.

Fluoroscopic evaluation of the upper aerodigestive tract after ingestion of contrast material can reveal defects in the posterior pharyngeal wall or fistulous tracts (Fig. 2) and also be used to assess the swallowing function.

MDCT provides images in the axial plane at a 1.25-mm thickness. Computer manipulation allows reconstruction of the images in any plane deemed necessary. Different window settings can highlight either the soft tissues or the bony structures of the head and neck, including the skull base and vertebral column. MRI acquires images in axial, coronal, or sagittal planes and, because of better contrast resolution between various tissues, can aid in identifying subtle changes, such as perineural tumor spread. Commonly used MR sequences include T1 weighted without and with contrast, which delineate the anatomy and pathologic conditions; the T2-weighted sequences show the water content of a region and is helpful in the differentiation between various lesions. The administration of intravenous contrast is important for both MDCT and MRI to determine the extent of disease, which is important for staging and treatment planning.

The RPS may be evaluated with ultrasonography by placing a transducer in the oral cavity and oropharynx; this technique is used for fine-needle aspiration (FNA) biopsy to evaluate RPS nodes. PET/CT allows the detection of disease in the RPS and PVS as well as distant disease spread throughout the body (Fig. 3). Lesions with increased glucose use, such as tumors, take up fluorodeoxyglucose (FDG) when imaged with PET. Because PET images do not provide adequate anatomic detail, they are fused with a CT scan for lesion localization (ie, the PET/CT study [see Fig. 3A]).

ANATOMY

The RPS extends from the clivus to the upper mediastinum, lies posterior to the pharynx and esophagus, and is anterior to the prevertebral musculature.^{4,5} It is bounded by the buccopharyngeal fascia anteriorly, the prevertebral fascia posteriorly, and the carotid space laterally (Fig. 4A). The very thin alar fascia, a part of the deep layer of the deep cervical fascia, extends from the medial border of the carotid space on either side and divides the RPS into 2 components: the anteriorly positioned true or proper RPS and the posteriorly situated danger space. The true RPS extends from the clivus inferiorly to a variable level between the T1 and T6 vertebrae where the alar fascia fuses with the visceral fascia to obliterate the true RPS.⁶ The danger space extends further inferiorly into the posterior mediastinum to the level of the diaphragm and is named as such because it provides a conduit for spread of infection from the pharynx to the mediastinum (see Fig. 4B).

The RPS can be further divided into the suprahyoid and infrahyoid RPS, each with different contents. The suprahyoid RPS contains fat and lymph nodes, whereas the infrahyoid RPS contains only fat and, thus, can be involved only by non-nodal disease. The suprahyoid retropharyngeal nodes lie medial to the medial aspect of the internal carotid artery⁷ at the level of the transverse process of the atlas and are divided into medial and lateral groups. The medial group of nodes is not consistently present and is located anterior to the medial parts of the longus colli muscles. The lateral group, also known as the nodes of Rouvière, lies ventral to the longus colli muscles.^{1,2,4–6,8} Retropharyngeal nodes are normally present in children and then atrophy in puberty. Small nodes may be present in two-thirds of asymptomatic adults and, when present, can be visible on imaging.⁸ Normal retropharyngeal nodes should be less than 1 cm in diameter.^{8,9}

The PVS is situated between the prevertebral fascia anteriorly and the vertebral bodies posteriorly (see Fig. 4); the contents include the prevertebral muscles and fat. Controversy exists in the literature regarding the lateral aspect of the PVS and whether or not the contents of a paravertebral space (ie, the scalene muscles, levator scapulae muscle, splenius capitis and splenius cervicis muscles, brachial plexus nerve roots, and vertebral artery and vein) should be included with the PVS to form a combined perivertebral space.¹⁰ Because the deep layer of the deep cervical fascia attaches to the transverse process for the cervical vertebrae, separating the PVS and the paravertebral space, the term PVS (*pre*vertebral space) is used in this article for identifying the region between the carotid sheaths laterally, the prevertebral fascia anteriorly, and the vertebral bodies posteriorly.¹¹

PRIMARY TUMORS OF THE RPS AND PVS

Primary tumors of the RPS are extremely uncommon. Lipoma (Fig. 5) is the most common primary neoplasm. Lipomas of the RPS appear elliptical on axial sections, conforming to the shape of the RPS.⁴ A lipoma may be differentiated from air (Fig. 6) on CT by use of the appropriate window width and window level settings because air is less dense (more black) than fat (as measured on CT with Hounsfield units). On MRI, fat has a hyperintense appearance on T1-weighted images and is suppressed with fat saturation techniques, often used in postcontrast T-weighted sequences.

Malignant neoplasms, such as liposarcoma and synovial sarcoma, are even rarer than lipomas in the RPS.^{12,13} Well-differentiated liposarcomas may have homogeneous adipose tissue, characterized by T1 signal hyperintensity, with only several thin septa.¹⁴ Features more suggestive of malignancy include greater than 25% non-adipose tissue, irregular margins, moderate to marked enhancement of thickened septa and nodules, large lesion size, and increased patient age.^{14,15}

Primary tumors of the PVS include tumors of the longus colli and longus capitis muscles and are predominantly sarcomas.

DIRECT SPREAD OF TUMOR TO THE RPS AND PVS

Pharyngeal masses, such as nasopharyngeal carcinoma (NPC) and squamous cell carcinoma of the oropharyngeal wall, can spread directly and invade the RPS. NPC involves the mucosal surface of the nasopharynx and its spread is initially limited by the pharyngobasilar fascia. Once this fascia is breached, NPC may extend posteriorly and inferiorly into the PVS (Fig. 7). A study by King and colleagues¹⁶ demonstrated that involvement of the prevertebral musculature occurred in 58 out of 150 patients (39%) with NPC. On MRI, NPC typically enhances less than normal mucosa and is not as intense on T2-weighted imaging.¹⁷ NPC may also spread superiorly to involve the skull base and the intracranial compartment through direct invasion or perineural spread. The presence of tumor spread into the clivus and intracranial compartment, together with the presence of systemic metastasis, favors a diagnosis of NPC over other pharyngeal carcinomas.¹⁸

Supraglottic, oropharyngeal, or sinonasal tumors may also grow into the RPS and can extend in a craniocaudal direction after gaining access because there are no fascial barriers within

the RPS. Superior spread in the RPS is impeded by the attachment of the buccopharyngeal fascia to the skull base, and disease spread may result in extensive erosion of the clivus.¹⁹

Lesions of the thyroid, including goiters, can extend posteriorly and medially into the RPS. Primary lesions of the spine and chordoma can invade the PVS and then the RPS from a posterior direction. Chordomas (Fig. 8) are midline lesions arising from the clivus, have variable enhancement, and are hyperintense on T2-weighted images.^{20,21} Clues to the location of a mass in the PVS include preservation but anterior displacement of RPS fat and effacement of the longus colli and longus capitis muscles, which are located anterior to the mass.

NODAL METASTASIS

NPC and squamous cell carcinoma of the oropharynx and larynx can metastasize to retropharyngeal nodes (Fig. 9), especially if there is involvement of the posterior pharyngeal wall. Other primary tumors associated with retropharyngeal nodal metastasis include tumors of the oral cavity and paranasal sinuses and non-squamous cell carcinoma lesions, such as papillary thyroid carcinoma, melanoma, and esthesioneuroblastoma.⁶ The imaging features of retropharyngeal nodal metastasis are focal nodal necrosis, ill-defined margins, or 2 or more involved nodes on 1 side of the RPS. A minimal axial diameter of 6 mm or more has been reported to have 87.5% accuracy for identifying malignant retropharyngeal nodes from NPC.²² Central necrosis or evidence of extracapsular spread should raise concern about metastatic involvement of retropharyngeal nodes, regardless of their size (Fig. 10).

A study by Wang and colleagues²³ demonstrated that in NPC, retropharyngeal nodes are involved less commonly than level IIB nodes (72.2% vs 86.5%). However, retropharyngeal nodes are considered N1 disease in the 2010 American Joint Committee on Cancer staging system for NPC because involvement of these nodes increases the risk of distant metastasis and affects prognosis²⁴; retropharyngeal nodal metastases are associated with poor treatment response and decreased survival because there is decreased control of disease in the neck.^{25,26}

If malignant-appearing nodes are seen in the RPS and there is no known primary tumor, the pharyngeal mucosal space and the nasopharynx should be thoroughly inspected for submucosal tumor.²⁷ Retropharyngeal nodes also indicate a poor prognosis in patients with primary lesions arising outside the nasopharynx.²⁸

OTHER LESIONS

Congenital lesions of the RPS include branchial cleft cyst (Fig. 11) and foregut duplication cysts. Ectopic parathyroid adenoma, or hyperplasia, may occur at the level of the pyriform sinus.²⁹ Other lesions that may affect the RPS and PVS include nerve sheath tumors (Fig. 12), vascular malformations, lymphatic malformations, hemangioma, and leiomyoma.

Radiation therapy is effectively used to treat a variety of head and neck malignancies. Fluid collections (Fig. 13) may appear 4 to 6 weeks after radiation therapy and usually disappear by 8 to 12 weeks. This fluid may accumulate in the RPS, conforms to the elliptical shape of

the RPS, and does not seem to be under tension as seen in RPS abscess (Fig. 14).³⁰ Soft tissue ulceration is another complication of radiation therapy³¹ and may extend from the pharyngeal wall into the RPS or PVS. These ulcerations may be benign (Fig. 15) or malignant; lack of associated enhancement suggests benignity.

Nonmalignant lesions arising from the vertebral bodies, including anterior disk bulges (Fig. 16) and spinal osteomyelitis (Fig. 17), may involve the PVS. Fluid collections, such as edema, suppurative adenitis, and RPS abscess (see Fig. 14), can mimic a malignancy. Clinical history and imaging findings, such as peripheral enhancement; soft tissue thickening; and reticulation in the surrounding soft tissues, such as the parapharyngeal or carotid spaces, are suggestive of inflammatory response.

In the case of primary involvement of the RPS by acute prevertebral calcific tendinitis, an inflammatory condition caused by deposition of calcium hydroxyapatite in the superior oblique tendon fibers of the longus colli muscles, there is a fluid collection and soft tissue swelling in the RPS. It is important to distinguish this process from an infectious cause. This differentiation can be achieved by the identification of calcific density in the longus colli (particularly at the C1–2 level) along with the aforementioned imaging features and avoids misdiagnosis, inappropriate medical treatment, and surgical drainage.³²

A tortuous carotid artery may mimic an RPS mass. In this condition, the vessel is not contained within the RPS but instead bows the alar fascia medially and projects into the RPS (Fig. 18). Unilateral jugular vein occlusion or jugular vein compression results in a low-attenuation collection in the RPS. Air in the RPS or PVS (see Fig. 6) may result from trauma, assisted ventilation, or foreign body ingestion.⁶

BIOPSY

Suspicious retropharyngeal nodes may be evaluated with FNA biopsy with CT using multiple approaches, including subzygomatic, premaxillary (Fig. 19), and retromandibular. A transoral approach through the oropharynx may be selected for ultrasonographic FNA of the RPS or PVS (Fig. 20). A high diagnostic yield has been reported when FNA specimens of head and neck lesions are interpreted by an experienced cytologist.^{33,34}

SUMMARY

Primary lesions of the RPS and PVS are rare. Most disease involvement of these spaces is the result of direct spread from adjacent sites or metastasis. Knowledge of the normal anatomy of these spaces, the common lesions affecting them, and the imaging and biopsy techniques used to evaluate such lesions will aid the head and neck surgeon who encounters them in clinical practice.

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Abbreviations

AP	Anteroposterior
FDG	Fluorodeoxyglucose
FNA	Fine needle aspiration
MDCT	Multidetector computed tomography
NPC	Nasopharyngeal carcinoma
PVS	Prevertebral space
RPS	Retropharyngeal space

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KEY POINTS

- Because of the deep location of the retropharyngeal space and prevertebral space within the neck, lesions arising within these spaces are difficult, if not impossible, to evaluate on clinical examination.
- Cross-sectional imaging plays an important role in the evaluation of the retropharyngeal space and prevertebral space and consists of various modalities: plain radiography, fluoroscopy, multidetector computed tomography, magnetic resonance imaging, ultrasonography, and positron emission tomography/computed tomography.
- Knowledge of the normal anatomy of these spaces, the common lesions affecting them, and the imaging and biopsy techniques used to evaluate such lesions will aid the head and neck surgeon who encounters them in clinical practice.

Fig. 1.

Thickening of the PVS. Lateral plane radiograph in a patient after total laryngectomy shows thickening of the RPS and PVS (arrows) secondary to reconstruction of the larynx and pharynx.

Fig. 2.

Fistulous tract between the aerodigestive tract and the RPS. Gastrografin contrast fluoroscopy image in a patient after chemotherapy and radiation therapy for base of tongue carcinoma shows a fistulous tract containing contrast (*large arrows*) between the aerodigestive tract and the RPS. Note presence of air (*small arrow*) superiorly in the RPS.

Fig. 3.

Metastatic melanoma. (A) Axial PET/CT scan shows a fluorodeoxyglucose-avid right lateral retropharyngeal node (*large arrow*) and bilateral neck nodes (*small arrows*). (B) PET image shows diffuse metastatic disease.

Fig. 4.

(A) Axial diagram of the retropharyngeal, danger, and prevertebral spaces with associated fascial planes. (B) The relationship of the retropharyngeal, danger, and prevertebral spaces.

Fig. 5.

Lipoma. Axial contrast-enhanced neck CT scan shows fat density (–20 Hounsfield units) in a right RPS lipoma (*arrow*).

Fig. 6.

PVS air collection. (A) Axial contrast-enhanced neck CTscan shows air (–920 Hounsfield units) (*arrow*) in the PVS. (B) Axial contrast-enhanced neck CT scan shows placement of a tracheostomy cannula (*large arrow*) in the soft tissues anterior to the trachea (*small arrow*).

Fig. 7.

NPC. (A) Sagittal T1 postcontrast MRI scan shows inferior extension of tumor (*large arrows*) into the RPS and PVS. Note the clival involvement (*small arrow*). (B) Axial PET/CT scan shows FDG-avid disease (*arrow*) in the RPS and PVS.

Fig. 8.

Chordoma. (A) Axial T1 postcontrast and (B) axial fast spin echo T2 MRI scans show a heterogeneously enhancing, T2-hyperintense PVS mass (*large arrow*) that is anteriorly displacing the prevertebral musculature (*small arrow*).

Fig. 9.

Retropharyngeal nodal metastasis. Axial T1 postcontrast MRI scan shows enlarged bilateral retropharyngeal nodes (*arrows*).

Fig. 10.

Retropharyngeal nodal metastasis. Axial contrast-enhanced neck CT scan shows a nonpathologically enlarged, centrally necrotic, right lateral retropharyngeal node (*arrow*).

Fig. 11.

Retropharyngeal cyst. Axial contrast-enhanced neck CT scan shows a branchial cleft cyst in the left RPS (*arrow*).

Fig. 12.

Schwannoma. Axial T1 postcontrast MRI scan with fat saturation shows a presumed right retropharyngeal schwannoma (*large arrow*) in a patient with neurofibromatosis 1. Nerve sheath tumor is seen extending out of the right neural foramen (*small arrow*).

Fig. 13.

Retropharyngeal fluid. Axial contrast-enhanced neck CT scan shows fluid in the retropharynx following radiation therapy (*large arrow*). A fat graft is noted in the oral cavity following total glossectomy (*small arrow*).

Fig. 14.

Retropharyngeal abscess. Axial contrast-enhanced neck CT scan shows a peripherally enhancing left RPS fluid collection (*large arrow*) under tension. Heterogeneous enhancement is present in the right RPS (*small arrow*) consistent with inflammatory change.

Fig. 15.

Soft tissue ulceration. Axial contrast-enhanced neck CT scan shows a radiation-associated ulceration (*arrow*) extending from the pharyngeal wall through the RPS and PVS to the anterior margin of the exposed vertebral body.

Fig. 16.

Anterior disk extrusion. Sagittal T1 postcontrast MRI scan with fat saturation shows an incidentally discovered anterior disk extrusion (*arrow*).

Fig. 17.

Prevertebral abscess/osteomyelitis. (A) Sagittal T1 postcontrast MRI scan, (B) sagittal fast spin echo T2 scan, and (C) axial T1 postcontrast MRI scan show infection of the vertebral column, epidural space, and the RPS and PVS (*small arrows*) characterized by soft tissue enhancement and a prevertebral abscess (*large arrows*).

Fig. 18.

Axial contrast-enhanced CT scan shows medial positioning of the internal carotid arteries (*arrows*) into the RPS.

Fig. 19.

CT-guided transfacial biopsy. Axial non-contrast-enhanced CT scan shows the biopsy needle (*arrow*) extending toward the right RPS.

Fig. 20.

Ultrasound-guided transoral FNA biopsy. Sonogram shows the biopsy needle (*large arrow*) extending into a right retropharyngeal lymph node (*small arrows*).

Table 1

Lesion of the retropharyngeal and prevertebral spaces

Primary lesions	Lipoma
	Liposarcoma
	Synovial sarcoma
Direct spread	Nasopharyngeal carcinoma
	Squamous cell carcinoma
	Supraglottic
	Oropharyngeal
	Sinonasal
	Lymphoma
	Thyroid, goiter
	Chordoma
	Primary spinal tumors
Nodal metastasis	Squamous cell carcinoma
	Pharyngeal
	Larynx
	Oral cavity
	Sinonasal
	Non-squamous cell carcinoma
	Lymphoma
	Papillary thyroid carcinoma
	Melanoma
Other	Esthesioneuroblastoma
	Branchial cleft cyst
	Foregut duplication cysts
	Ectopic parathyroid adenoma
	Nerve sheath tumors
	Vascular malformations
	Lymphatic malformations
	Hemangioma
	Leiomyoma
	Disk bulge
	Edema
	Osteomyelitis
	Abscess
	Calcific tendinitis
	Tortuous carotid artery