The retrocrural space (RCS) is a small triangular region within the most inferior posterior mediastinum bordered by the two diaphragmatic crura. Multiplanar imaging modalities such as computed tomography and magnetic resonance imaging allow evaluation of the RCS as part of routine examinations of the chest, abdomen, and spine. Normal structures within the retrocrural region include the aorta, nerves, the azygos and hemiazygos veins, the cisterna chyli with the thoracic duct, fat, and lymph nodes. There is a wide range of normal variants of the diaphragmatic crura and of structures within the RCS. Diverse pathologic processes can occur within this region, including benign tumors (lipoma, neurofibroma, lymphangioma), malignant tumors (sarcoma, neuroblastoma, metastases), vascular abnormalities (aortic aneurysm, hematoma, azygos and hemiazygos continuation of the inferior vena cava), and abscesses. An understanding of the anatomy, normal variants, and pathologic conditions of the diaphragmatic crura and retrocrural structures facilitates diagnosis of disease processes within this often overlooked anatomic compartment.

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LEARNING OBJECTIVES

After reading this article and taking the test, the reader will be able to:

■ Describe the normal imaging appearance of the retrocrural space and its normal variants.
■ Identify the anatomic structures that are normally encountered in the retrocrural space.
■ List the imaging findings associated with the spectrum of pathologic conditions that may affect the retrocrural space.

TEACHING POINTS

See last page

Abbreviations: AIDS = acquired immunodeficiency syndrome, IVC = inferior vena cava, RCS = retrocrural space

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Introduction

With the advent of computed tomography (CT) as an imaging modality for evaluating the thorax and abdomen, the retrocrural space (RCS) gained importance as an anatomic landmark among radiologists. Multiplanar imaging modalities such as CT and magnetic resonance (MR) imaging have allowed evaluation of the RCS as part of routine examinations of the chest, abdomen, and spine. There is a wide range of normal variants of the diaphragmatic crura and of structures within the RCS. Similarly, diverse pathologic processes can occur within this region including congenital, inflammatory, neoplastic, vascular, and infectious conditions.

In this article, we review the relevant embryology and anatomy of the RCS as well as the normal variants and pathologic conditions occurring within this small but important imaging landmark.

Embryology

The diaphragm forms from the 4th to 12th weeks of embryonic life. By the 4th week of embryonic life, the coelom or body cavity appears as a horse-shoe-shaped cavity in the cardiogenic and lateral mesoderm; this cavity will later give origin to the thoracic and peritoneal cavities. By the 6th week, the pleuropericardial membranes extend medially and their free edges fuse with the mesentery of the esophagus and with the septum transversum, separating the pleural cavities from the peritoneal cavity. Further growth of myoblasts will ensure pleuropertoneal openings, forming the posterolateral elements of the diaphragm. The dorsal mesentery of the esophagus constitutes the median portion of the diaphragm. The diaphragmatic crura develop from myoblasts that grow into the dorsal mesentery of the esophagus (1) (Fig 1).

Anatomic Considerations

In cross-sectional imaging, the RCS can be defined as a triangular region that represents the most inferior portion of the posterior mediastinum, with no true boundaries from the posteromedial aspect of the thoracic cavity. The space is delimited anteriorly and laterally by the diaphragmatic crura as they pass from the anterolateral aspects of the vertebral bodies and ascend to decussate in front of the aorta. Posteriorly, boundaries include the ventral aspect of the distal thoracic and proximal lumbar vertebral bodies. The RCS communicates with the posterior mediastinum and the retroperitoneum, being a potential pathway for extension of diverse pathologic conditions between these spaces. The contents of the RCS include fat, vascular structures (ie, aorta and arterial branches, azygos and hemiazygos veins), neural structures (ie, sympathetic trunks and splanchnic nerves), lymph structures (ie, lymph nodes, thoracic duct, and cisterna chyli), and other less distinct structures (eg, ascending lumbar venous plexus) (2) (Fig 2).
The peripheral diaphragm is formed by muscular fibers attached to three different anatomic regions: the sternum, inferior ribs, and lumbar region. The lumbar portion attaches to the med-ial and lateral lumbocostal arches (arcuate ligaments) and to the anterolateral surfaces of the lumbar vertebral columns as bilateral musculotendinous pillars, known as the diaphragmatic crura (Fig 3).

There are two pairs of lumbocostal arches or arcuate ligaments: the medial and lateral arcuate ligaments. The medial arcuate ligament arches over the psoas major muscle and attaches laterally to the 12th rib and medially to the transverse process of L1 (3).

The term crura, the plural of crus, is derived from the Latin word cruralis, meaning “leg.” The tendinous aspect of the right crus attaches to the ventral surface of the lumbar vertebral bodies and to the intervertebral fibrocartilage of the first three lumbar vertebral columns. The right crus is longer and broader than the left. The shorter left crus attaches to corresponding structures of the first two lumbar vertebral bodies only. As the two crura ascend, their medial fibers are conjoined, forming an arch ventral to the aorta and just above the celiac trunk. This sometimes indistinct arch is known as the median arcuate ligament. Other medial fibers of the right crus continue to surround the distal esophagus, forming the esophageal hiatus, with some superficial fibers extending around the left margin of the distal esophagus and the deeper fibers running along the right margin. A fasciculus of the medial aspect of the left crus crosses the aorta ventrally and runs along the lateral deeper fibers of the right crus toward the vena cava hiatus (Figs 4, 5).

Laterally, the medial arcuate ligament attaches to the anterior aspect of the transverse process of the first lumbar vertebra. The lateral arcuate ligament arches over the quadratus lumborum and attaches laterally to the 12th rib and medially to the transverse process of L1 (3).

The aorta, the thoracic duct, some lymphatic trunks, and sometimes the azygos and
hemiazygos veins pass through the aortic hiatus, which is the most posterior of the diaphragmatic apertures (4).

**Lymph Nodes, Cisterna Chyli, and Thoracic Duct**

The lymph nodes of the RCS are lymphatic draining stations for the posterior diaphragm, posterior mediastinum, and lumbar spine and can measure up to 6 mm along the short axis (5).

The cisterna chyli is a bulbous dilatation formed by the convergence of lymphatic channels at the level of the upper lumbar vertebral bodies. It receives two afferent lumbar and intestinal lymphatic trunks and finally ascends as the thoracic duct. It is usually located to the right of the aorta, but left-sided or retroaortic locations have also been described (2,6) (Fig 6).

The cisterna chyli can be seen in up to 52% of patients at lymphangiography, 1.7% at CT, and 15%–96% at MR imaging (2,7,8). It has a variable morphology including tubular (most common; 30%–42.5% of cases), rounded, oval, plexiform, and fusiform (2). At CT it has low attenuation, near that of water. Delayed enhancement has been described at CT after oral ingestion of ethiodized oil or intravenous injection of contrast material (9–11) (Fig 7).

**Aorta**

At the level of the aortic hiatus, the aorta is slightly to the left of midline. Important arterial branches that arise from the descending aorta within this region are the lower posterior intercostal and subcostal arteries.
of competent valves. The absence of valves is also responsible for the potential retrograde venous flow, which may contribute as a pathway for distant spread of neoplasms and infections (Fig 8).

**Sympathetic Trunk and Splanchnic Nerves**

The thoracic sympathetic trunk passes either dorsal to the medial arcuate ligament or runs through the diaphragmatic crura to become the lumbar sympathetic trunk. The medial branches of the lower sympathetic ganglia supply the aorta and unite to form the greater, lesser, and lowest splanchnic nerves, all of which descend obliquely and lateral to the distal thoracic vertebral bodies. After piercing the diaphragmatic crura, sympathetic fibers from the greater and lesser splanchnic nerves end in the celiac ganglia. Understanding the anatomy of the sympathetic trunk and splanchnic nerves within the retrocrural region has gained importance with the advent of imaging-guided techniques for percutaneous blockade of the celiac plexus.

**Anatomic Variants and Anomalies**

**Anomalies and Variations of the Diaphragmatic Crura**

In comparison with other more common congenital diaphragmatic anomalies like agenesis or Bochdalek, Morgagni, and hiatal hernias, anomalies affecting the crura are often less symptomatic and are usually detected incidentally during imaging (12,13).

Partial duplication of the diaphragm may involve the crura. It is thought to result from improper timing in the interaction of the lung buds and septum transversum. The condition is associated with cardiovascular malformations and ipsilateral pulmonary maldevelopment. The duplicated accessory diaphragm extends obliquely upward and backward to attach to the third to seventh ribs posteriorly. This anomaly is more frequently right sided; at cross-sectional imaging, the lower lobe of the lung may be partially or completely contained within the accessory diaphragm and the true hemidiaphragm (13,14) (Fig 9).

Discontinuity of the diaphragm between the crura and the lateral arcuate ligaments is a normal variation encountered in 11% of normal patients and should not be confused with diaphragmatic rupture (15). An association with aging suggests that atrophy can be related to an

**Azygos and Hemiazygos Veins**

The azygos vein is right sided and most frequently arises from the junction of the lumbar azygos with the right ascending lumbar and subcostal veins. It enters the chest through the right crus or through the RCS via the aortic hiatus and ascends along the right anterolateral surface of the thoracic spine. In a similar fashion, but on the left side, the hemiazygos vein originates at the junction of the left ascending lumbar and left subcostal veins.

**Paravertebral Venous Plexus**

A network of valveless venous systems freely communicates along the entire extent of the vertebral column. The relative increased venous pressure of this venous network enables blood to flow from the vertebrae to the caval venous system. There is free communication between the veins of the neck, thorax, abdomen, and pelvis and the vertebral venous plexus owing to the lack

**Figure 8.** Paravertebral venous plexus. Diagram shows the anterior external vertebral venous plexus (AEVV), with veins that can be seen in the RCS. AIVV = anterior internal vertebral (epidural) venous plexus.

**Figure 9.** Normal crural variation in a 50-year-old man. CT image shows a duplicated or accessory right hemidiaphragm (arrow). This is an uncommon anomaly that can be seen as an incidental finding or in association with recurrent pulmonary infections related to pulmonary sequestration. Note the second linear area of increased attenuation within the right RCS.
of venous blood from the lower abdomen, pelvis, and lower extremities into the azygos or hemiazygos venous systems (17). An enlarged azygos vein receives venous blood from the renal portion of the IVC and passes within the RCS, accessing the thorax to drain into the superior vena cava. At axial CT or MR imaging, the enlarged azygos vein can be recognized as a well-defined tubular structure that parallels the aorta behind the diaphragmatic crura and extends cephalad to communicate with the azygos arch. There is intense enhancement after intravenous contrast material administration (Fig 12).

Other IVC congenital anomalies that manifest as enlarged retrocrural azygos and hemiazygos veins include absence of the infrarenal IVC and duplication of the IVC with azygos or hemiazygos continuation (18,19). Knowledge and recognition of these vascular anomalies avoids misinterpreta-
Other nonneoplastic conditions that can involve the diaphragmatic crura include infectious processes such as intracrural abscess and traumatic rupture. Thickening of the crura has been described as an indicator for diaphragmatic injury in the setting of trauma (20,21). However, normal thickness variations related to respiration or the patient’s age limit the use of this parameter as an indicator of traumatic diaphragmatic injury.

Abnormalities of the RCS

Lymphadenopathy.—Lymph nodes dorsal to the diaphragmatic crura drain the posterior mediastinum and diaphragm as well as the lumbar regions (3). Detection of enlarged retrocrural lymph nodes exceeding 6 mm in diameter should be considered suspiciously abnormal (Fig 15).

Enlarged retrocrural lymph nodes are associated with inflammatory, infectious, and most frequently neoplastic conditions. Cephalic spread of metastatic genitourinary or gastrointestinal malignancies or caudal extension of thoracic malignancies such as esophageal and lung carcinomas may manifest as enlarged lymph nodes within the retrocrural region (22,23). In addition, lymphoma—either Hodgkin or non-Hodgkin—is a common malignant cause of enlarged lymph nodes or nodal masses within the RCS. As with other anatomic compartments, there are limitations to use of size criteria to determine malignant involvement because metastases can occur in normal-sized nodes.

Inflammatory conditions that manifest with generalized lymph node enlargement such as...
Retrocrural Neoplasms.—Primary neoplasms that arise in or extend to involve the RCS resemble the imaging presentation of other primary neoplasms of the posterior mediastinum. These can be categorized according to their cell of origin into neurogenic, mesenchymal, germ cell, and lymphoid tumors.

Retrocrural neurogenic tumors can be divided into three categories: ganglion cell tumors, nerve and nerve sheath tumors, and tumors of the paraganglia (28). Tumors derived from ganglion cells such as neuroblastoma, ganglioneuroblastoma, and ganglioneuroma are the most common posterior mediastinal masses encountered during early childhood. These tumors are derived from sympathetic ganglion cells arising from the sympathetic chain along the paravertebral region and range from malignant masses (neuroblastoma) to benign tumors (ganglioneuroma). The child’s age at presentation, the presence of skeletal metastases, calcification within the tumor, and the pattern of enhancement at both CT and MR imaging can help differentiate between the three (29,30).

Although CT has been the most commonly used imaging modality for assessment of ganglion cell tumors and is especially useful in detecting calcification within the masses, MR imaging is superior in evaluating the extent of the more malignant neurogenic tumors owing to its superior multiplanar imaging capability (29). At MR imaging, neuroblastoma—the most common of the three—has prolonged T1 and T2 relaxation times, appearing with low signal intensity on T1-

Causes of Retrocrural Lymphadenopathy

- Inflammatory and miscellaneous conditions
  - Sarcoidosis
  - Lymphangioleiomyomatosis
  - Amyloidosis
- Infections
  - AIDS
  - Tuberculosis
  - M. avium-intracellulare complex
- Lymphoma
- Metastatic disease
  - Neuroblastoma
  - Sarcoma
  - Malignant pleural mesothelioma
  - Testicular germ cell tumor
  - Esophageal carcinoma
  - Lung carcinoma
  - Gastric carcinoma
  - Ovarian carcinoma
  - Cervical carcinoma
  - Colorectal carcinoma
  - Renal cell carcinoma
  - Prostate carcinoma
  - Bladder carcinoma

Figure 16. Large posterior mediastinal neuroblastoma extending into the RCS in a 3-year-old boy. (a) Axial T1-weighted MR image shows a large mass (arrow) displacing the left hemidiaphragm anteriorly (arrowheads). (b) Coronal T2-weighted MR image shows the left diaphragm pushed inferiorly (black arrow) by the RCS mass (arrowheads). The right crus is normal (white arrow). MR imaging characteristics of low signal intensity on T1-weighted images and high signal intensity on T2-weighted images are typical of neurogenic tumors.
dentally detected in young to middle-aged women. The central cystic degeneration of neurilemomas can be readily recognized at both CT and MR imaging; however, the peripheral calcification is better depicted with nonenhanced CT. Ten percent of nerve sheath tumors demonstrate intraspinal extension with neural foramina enlargement and have a “dumbbell” appearance (33). Overall, these benign nerve sheath tumors manifest as smooth oval masses with well-defined margins and are often indistinguishable with imaging alone.

Paraganglioma is an even less common aggressive neurogenic tumor that can occur within the RCS as well. These hypervascular tumors arise from paraganglionic cells near the aortico-sympathetic chain (34) and more frequently affect patients during the second or third decade of life. Patients with functional paragangliomas have hypertension and biochemical evidence of excess catecholamine production. Paragangliomas range from 1 to 6 cm in diameter and demonstrate brisk enhancement after intravenous administration of contrast material on both CT and T1-weighted MR images. The typical uniform high signal intensity on T2-weighted MR images has been reported in 80% of studies (28). m-iodobenzylguanidine scanning can be diagnostic in functioning tumors (35). Owing to their hypervascularity, it is important to consider these paraganglionic tumors as a potential cause of spontaneous acute hemorrhage within the RCS and retroperitoneum.

As elsewhere within the mediastinum, mesenchymal neoplasms of the RCS are infrequently encountered. Among tumors of mesenchymal origin, lipoma and liposarcoma are probably the least uncommon and can appear de novo or gain access into the RCS from the posterior mediastinum or retroperitoneum. These fat-containing tumors are slow growing and usually large at presentation (36). Other less frequently encountered neoplasms of mesenchymal origin include other types of sarcomatous tumors (rhabdomyosarcoma, leiomyosarcoma, and fibrosarcoma), malignant fibrous histiocytoma, leiomyoma, lymphangioma, and tumors of blood vessel origin like hemangiopericytoma and hemangioma (30,37,38). Similarly, these may be retrocrural in origin or extend into the RCS from the posterior mediastinum or retroperitoneum (Fig 17).

Among tumors of germ cell origin, teratoma is a neoplasm incidentally found in asymptomatic patients. Mediastinal teratomas, although unusual, have been more frequently reported in the anterior mediastinum; however, a few have been reported in the posterior mediastinum along the paravertebral
regions (39). When teratomas manifest with pathognomonic features such as the presence of fat, fluid, soft tissue, and especially calcification, they can be readily recognized and usually differentiated from other more aggressive fat-containing tumors such as liposarcomas (40,41).

Seminomatous and nonseminomatous malignant germ cell tumors involve the RCS by metastatic spread of tumor from a gonadal primary or by direct invasion from posterior mediastinal or retroperitoneal primaries. Malignant germ cell tumors arise from primitive germ cells that failed to migrate into the scrotum during development. The majority of malignant germ cell tumors occur in men between the ages of 20 and 35 years. Seminomatous tumors usually manifest as well-marginated, large, bulky masses that demonstrate homogeneous attenuation at CT, reflecting their uniform cellular nature (42). Nonseminomatous germ cell tumors are also large aggressive tumors, with irregular margins and a heterogeneous appearance due to areas of hemorrhage and necrosis (40).

Lymphoma encompasses a diverse group of lymphoid neoplastic processes that are well known to cause enlarged retrocrural lymph nodes or nodal masses. Involvement of retrocrural and para-aortic lymph nodes is generally accompanied by a similar presentation involving other lymphatic nodal groups in the mediastinum or retroperitoneum. Both Hodgkin disease and non-Hodgkin lymphoma can involve retrocrural lymph nodes. Fifty percent of patients with non-Hodgkin lymphoma have positive high para-aortic lymph nodes at presentation compared to 25% with Hodgkin disease (43). Patients with non-Hodgkin lymphoma present with larger nodal masses compared to those with Hodgkin disease. A bulky nodal mass larger than 1.5 cm that surrounds and displaces the aorta away from the spine is the typical presentation of non-Hodgkin lymphoma within the RCS (Fig 18).

Extramedullary hematopoiesis is an unusual benign neoplastic process that can manifest as soft-tissue masses within the retrocrural region. This unusual condition arises as a compensatory phenomenon in patients with long-standing anemia. There is reactive expansion of the erythropoietic tissue that has extruded from the vertebral bodies and posterior ribs, resulting in bilateral paraspinous masses (44). Although more frequently described in patients with thalassemia, it may also be seen in those with sickle cell disease, hereditary spherocytosis, myelosclerosis, and other causes of anemia and myeloproliferative disorders (45). CT usually demonstrates well-defined soft-tissue masses at multiple levels along the distal thoracic paraspinous region. Faint enhancement after intravenous contrast material administration is demonstrated at both CT and MR imaging. These lobulated soft-tissue masses may have areas of fat attenuation at CT (Fig 19).

MR imaging features of extramedullary hematopoiesis depend on the level of activity of the hematopoietic lesion. In active hematopoietic lesions, there is intermediate signal intensity on T1-weighted images and high signal intensity on T2-weighted images in relation to muscle, with slight enhancement after administration of gadolinium contrast material. In older inactive lesions, low signal intensity on both T1- and T2-weighted
such as infection and malignant transformation (48). Foregut malformations arise from abnormal budding of the primitive foregut between the 3rd and 7th weeks of embryonic development (49). Foregut duplication cysts can be divided into enterogenous and bronchogenic cysts. When detected at CT, these lesions demonstrate variable attenuation values without enhancement after intravenous contrast material administration. At MR imaging, the cysts have variable signal intensity on T1-weighted images and high signal intensity on T2-weighted images (50,51).

**Vascular Disorders**.—The aorta is the largest anatomic structure confined within the RCS. Disease processes of the aorta, including ruptured aneurysm and pseudoaneurysm, traumatic rupture, and inflammatory conditions such as aortitis, can all manifest as abnormalities radiologically evident within the retrocrural region.

Infiltrative appearing soft-tissue attenuation that replaces the normal retrocrural fat surrounding the aorta is the characteristic CT appearance of acute periaortic hematoma. Periaortic hematoma within the RCS is present in patients with traumatic aortic injury or aneurysm rupture as well as in periaortic bleeding caused by translumbar access for aortography (52). The clinical setting and ancillary imaging findings such as aortic size, contour abnormalities, extravasation of contrast material, and displacement from mass effect of adjacent anatomic structures aid in identifying the cause and nature of the retrocrural periaortic hematoma (Fig 20). In the setting of trauma, periaortic hematoma within the retrocrural region can also be present secondary to posterior diaphragmatic rupture or vertebral body and rib fractures or related to dissection of a hematoma from a more proximal thoracic aortic laceration (53,54) (Fig 21).

Chronic periaortitis encompasses a series of inflammatory conditions with a suspected autoimmune pathogenesis. Among these entities, which can manifest as circumaortic fibrotic changes, the most representative are giant cell arteritis, Takayasu arteritis, periaortic fibrosis, and inflammatory aortic aneurysm; all are known to involve the distal thoracic and proximal abdominal aorta. Periaortic inflammatory changes within the RCS can be well depicted with cross-sectional imaging (CT or MR imaging) or angiography and recently with positron emission tomography (Fig 22). Delayed enhancement of the thickened aortic wall after intravenous contrast material administration suggests aortitis at both CT and MR images is seen secondary to deposition of iron, whereas high signal intensity on both image types is visualized when there is significant fatty infiltration (46).

**Foregut Malformations**.—Although usually found in the middle mediastinum within the paratracheal or subcarinal region, foregut malformations within the posterior mediastinum and retroperitoneum extending to occupy the RCS have been described in isolated case reports. Simultaneous retrocrural presentation of pulmonary sequestration with gastric and esophageal duplication cysts has been described (47). Recognizing these malformations usually prompts surgical resection in order to reach a definitive diagnosis and to prevent potential complications.
imaging. Infectious aortitis caused by bacterial and mycobacterial infections may have a similar imaging appearance.

Other vascular abnormalities evident within the retrocrural region can involve smaller vessels such as the intercostal arteries and veins as well as the perivertebral venous plexus. Portal hypertension, caval occlusion, and other central venous occlusions can alter the normal venous drainage, altering the flow within the azygos-hemiazygos venous system. Obstructive central venous processes and portal hypertension can manifest as varices of the intercostal veins, ascending lumbar veins, and perivertebral venous plexus (5,55,56). Hypertrophied intercostal arteries traversing the RCS can be seen in patients with chronic pulmonary inflammation, long-standing active tuberculosis, pulmonary thromboembolism, chronic obstructive pulmonary disease, and severe bronchiectasis (57) (Fig 23).

Compression of the renal artery by the crura has been recognized as an unusual cause for renal artery stenosis and renovascular hypertension (58). An atypical high and posterior origin of the left renal artery appearing entrapped within the RCS by the diaphragmatic crus can be adequately recognized with contrast-enhanced helical CT and especially with CT angiography (59) (Fig 24).

Inflammatory Conditions.—Retroperitoneal fibrosis is an uncommon chronic inflammatory condition of unknown pathogenesis that is characterized by replacement of the retroperitoneal tissues, especially fat, with fibrous tissue.
Evaluation values of the paraspinal fat have been well demonstrated with CT and have allowed specific diagnosis of this unusual inflammatory condition (64). Other iatrogenic causes for lipomatosis such as that caused by antiretroviral agents in patients with human immunodeficiency virus infection can also trigger increased accumulation of fat within the retrocrural region (65,66) (Fig 25).

Spondylosis deformans is a very common degenerative disease of the spine that manifests as osteophyte formation along the anterolateral aspect of the vertebral bodies. When large enough, the bone excrescences arising from the distal thoracic vertebral bodies often project into the RCS. Thoracic spine osteophytes are more frequently encountered along the right anterolateral aspect, presumably because the pulsations of the descending aorta on the left side inhibit bone production (5) (Fig 26).

Pancreatic pseudocysts are encapsulated collections containing necrotic debris, pancreatic secretions, and blood degradation products that originate from the pancreas after pancreatitis. Retroperitoneal and transhiatal extension of pancreatic inflammation explains the unusual presentation of pancreatic pseudocysts within the retrocrural region and posterior mediastinum. A pancreatic pseudocyst within the RCS can be suspected when there is rapid development of a fluid collection in this region in a patient with the clinical diagnosis of pancreatitis (Fig 27). A history of alcohol abuse, recurrent pancreatitis, and the appropriate laboratory test results demonstrating increased amylase and lipase levels support the diagnosis (67). CT and MR imaging both clearly demonstrate the cystic nature of the lesion and its communication with an intraabdominal pancreatic pseudocyst.
Infections.—Infections involving the distal thoracic and proximal lumbar spine can extend to involve the RCS by extraspinal extension into the prevertebral and paravertebral soft tissues. Paraspinal abscesses are associated with pyogenic spondylitis—particularly due to *Staphylococcus*—and tuberculous spondylitis (68) (Fig 28). Infectious spondylitis occurs more frequently in men, with the highest frequency during the sixth decade of life. Diabetes, immunosuppression, intravenous drug abuse, sickle cell anemia, and urinary tract infections are known predisposing factors for infectious spondylitis. The prevalence of tuberculous spondylitis is higher in developing countries and is increasing because of the resurgence of tuberculosis, especially in patients with AIDS. Infectious spondylitis may manifest as destruction of the vertebral body endplates and of the intervertebral disk. Associated compression deformities of the vertebral bodies can also be identified. Hematogenous spread of microorganisms into the vertebral bone marrow through perivertebral arterial branches or venous plexuses is the most common source of infection. However, direct inoculation secondary to iatrogenic causes is another possible route for development of infectious spondylitis and paraspinal abscesses. Once the vertebral body is involved, subligamentous spread of infection can occur. Extension into the prevertebral soft tissues occurs by discharge through sinus tracts.

CT and especially MR are the imaging modalities of choice for detection of paraspinal abscesses in patients with infectious spondylitis (69,70). However, MR imaging is superior to CT in detecting associated vertebral, intervertebral disk, and epidural involvement. Use of intravenous contrast material significantly increases the sensitivity for detecting spondylodiscitis and paraspinal abscesses. Abscess walls are hypervascular and typically enhance after intravenous contrast material administration. Retrocrural abscesses manifest as single or multiple fluid collections just dorsal to the crura with associated obliteration of the normal retrocrural fat planes (Fig 29). Anterolateral crural displacement and abscess wall enhancement after intravenous contrast material administration can also be identified. The presence of calcification suggests chronicity, such as in more indolent infectious processes like tuberculous infections. Tuberculous spondylitis more frequently involves
Patients with distal esophageal perforation; however, it is not specific to this condition. CT more readily demonstrates the presence of gas within the RCS than does radiography (Fig 30).

Pleural effusion is perhaps the most frequently detected abnormality occupying the RCS. Free pleural fluid first accumulates within the posterior pleural recess in patients being imaged in the supine position. As little as 15 mL of pleural fluid is needed to demonstrate pleural fluid occupying the posterior recess at CT or MR imaging. Axial CT or MR imaging demonstrates pleural fluid within the posterior pleural recess posterior and medial to the diaphragmatic crus, displacing the crus anteriorly and laterally. This pattern contrasts with that of upper abdominal intraperitoneal fluid collections, which lie anterolateral to the diaphragmatic crura (74).

Acute traumatic fractures of the distal thoracic and proximal lumbar vertebrae can be associated with paravertebral hematomas that can occupy the RCS. These fractures are usually related to high-energy blunt trauma. Other associated conditions such as anticoagulation or underlying pathologic conditions like ankylosing spondylitis can predispose to vertebral body fractures and development of a paraspinal hematoma. The hematoma results from tearing of the anterior longitudinal ligament at the fractured vertebra and from hemorrhage produced by disruption of the small anterior vertebral branching arteries and venous plexus.

Retrocrural hematomas can be readily detected with CT, since it is commonly used as the imaging modality in the setting of trauma. Besides the imaging findings related to the fracture of the adjacent distal thoracic or proximal lumbar vertebra, CT of retrocrural hematomas demonstrates infiltration of the normal retrocrural fat planes with soft-tissue attenuation present behind the crura (5). Associated aortic displacement with bulging and thickening of the diaphragmatic crura can also be present (Fig 31).

Conclusions
Despite the small area that encompasses the RCS, there is a wide variety of pathologic conditions within this region, which is located at the posterior confines of the inferior thorax and upper abdomen. An understanding of the anatomy, the normal variants, and the multiple pathologic conditions affecting the diaphragmatic crura and retrocrural structures facilitates the diagnosis of disease processes within this often overlooked anatomic compartment.

Other Abnormalities.—Pneumomediastinum can be recognized by the presence of gas within the RCS outlining the aorta. The combination of paraspinal and extrapleural diaphragmatic gas at chest radiography was described by Naclerio (72). The sharply angulated radiolucent shadow that resembles a V and is known as the V sign of pneumomediastinum corresponds to gas that extends between the parietal pleura and the medial portion of the left hemidiaphragm, outlining the descending aorta (72,73). This presentation of pneumomediastinum was initially reported in patients with distal esophageal perforation; however, it is not specific to this condition. CT more readily demonstrates the presence of gas within the RCS than does radiography (Fig 30).

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References


The Diaphragmatic Crura and Retrocrural Space: Normal Imaging Appearance, Variants, and Pathologic Conditions

Carlos S. Restrepo, MD, et al

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In cross-sectional imaging, the RCS can be defined as a triangular region that represents the most inferior portion of the posterior mediastinum, with no true boundaries from the posteromedial aspect of the thoracic cavity. The space is delimited anteriorly and laterally by the diaphragmatic crura as they pass from the anterolateral aspects of the vertebral bodies and ascend to decussate in front of the aorta. Posteriorly, boundaries include the ventral aspect of the distal thoracic and proximal lumbar vertebral bodies.

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Lymph nodes dorsal to the diaphragmatic crura drain the posterior mediastinum and diaphragm as well as the lumbar regions (3). Detection of enlarged retrocrural lymph nodes exceeding 6 mm in diameter should be considered suspiciously abnormal (Fig 15).

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Primary neoplasms that arise in or extend to involve the RCS resemble the imaging presentation of other primary neoplasms of the posterior mediastinum. These can be categorized according to their cell of origin into neurogenic, mesenchymal, germ cell, and lymphoid tumors.

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Both Hodgkin disease and non-Hodgkin lymphoma can involve retrocrural lymph nodes. Fifty percent of patients with non-Hodgkin lymphoma have positive high para-aortic lymph nodes at presentation compared to 25% with Hodgkin disease (43).

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CT and especially MR are the imaging modalities of choice for detection of paraspinal abscesses in patients with infectious spondylitis (69,70). However, MR imaging is superior to CT in detecting associated vertebral, intervertebral disk, and epidural involvement.