Pictorial Essay

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CT Findings of Azygos Venous System: Congenital Variants and Acquired Structural Changes

기정맥계의 CT 소견: 선천변이 및 후천적 구조 변화

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The azygos venous system is a crucial conduit of the posterior thorax and potentially vital collateral pathway. However, it is often overlooked clinically and radiologically. This pictorial essay reviews the normal azygos venous anatomy and CT findings of congenital variations and structural changes associated with acquired pathologies.

Index terms Azygos Vein; Inferior Vena Cava; Superior Vena Cava; Left Superior Intercostal Vein; Collateral Pathway

INTRODUCTION

The azygos venous system can be affected by various congenital variations or acquired conditions, including increased venous pressure and compromise of the superior vena cava (SVC) or inferior vena cava (IVC). However, these variants are occasionally overlooked or misinterpreted as masses or lymphadenopathies (1). With the increasing accessibility of CT, evaluating the detailed anatomy of the azygos vein and its surrounding structures as well as any associated pathological changes and potential complications has become feasible. CT can reveal these findings and their underlying hemodynamic relationships. Therefore, a compre-

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hensive understanding of the CT findings of these variations and conditions is essential to their accurate diagnosis and proper management.

This pictorial essay aimed to overview the normal anatomy of the azygos venous system, its congenital variations, and its acquired conditions along with their associated CT findings.

NORMAL ANATOMY

The azygos venous system is a network of veins that serves as an accessory pathway between the SVC and the IVC. It plays a crucial role in draining the thoracic cage and part of the posterior mediastinum into the SVC (2). This system comprises three main veins: the azygos, hemiazygos, and accessory hemiazygos. The left superior intercostal vein (LSIV), also part of this system, provides a collateral pathway for blood back to the heart by connecting the left brachiocephalic vein and the accessory hemiazygos vein. Embryologically, the azygos vein is formed by persistence of the cranial part of the right supra-cardinal vein and terminal part of the right posterior cardinal vein (3), whereas the hemiazygos and accessory hemiazygos veins are formed by the cranial part of the left supra-cardinal vein (4).

The azygos vein arises at the connection between the right ascending lumbar vein and the right subcostal vein around T12 and passes through the diaphragm via the aortic hiatus (Fig. 1). It then ascends along the right surface of the vertebral column, arches superior to the right main bronchus, and ultimately drains into the SVC at the T4–T5 level (Fig. 1) (5). Conversely, the hemiazygos vein ascends along the vertebral column on the opposite side of the azygos vein, corresponding to the lower part of the azygos vein. It crosses right behind the aorta and esophagus, draining into the azygos vein at the T8–T9 level (Fig. 1). At this level, the hemiazygos vein communicates with the accessory hemiazygos vein, which corresponds to the upper azygos vein. The LSIV drains the second, third, and sometimes fourth left intercostal spaces. After communicating with the accessory hemiazygos vein in approximately 75% of patients, the LSIV arches anteriorly lateral to the aortic arch and joins the left brachiocephalic vein (Fig. 1) (6).

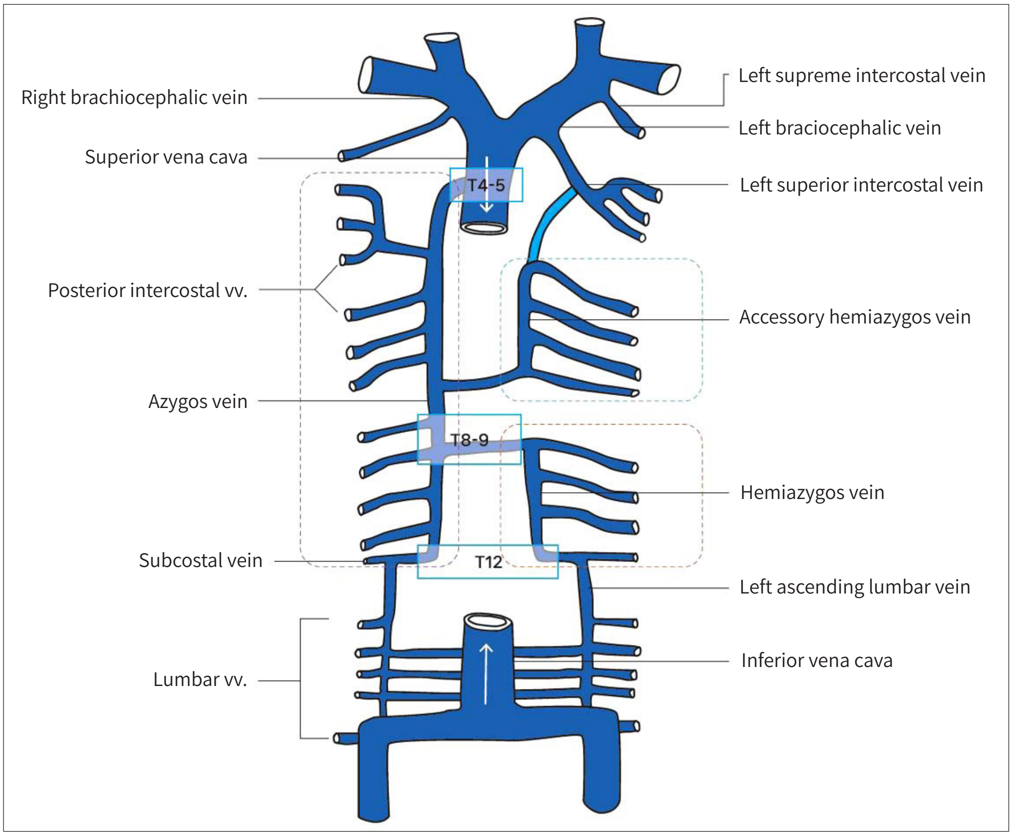
CONGENITAL VARIANTS

The azygos venous system presents with several classical or rare congenital variations that can be detected incidentally on plain radiography or CT. Congenital variants of the azygos vein can occur in isolation; however, they frequently coexist with other venous anomalies, reflecting the intricate embryonic development of this system (7). This paper describes the various congenital variants of the azygos vein and discuss the associated variations in the surrounding structures.

ABSENCE OF AZYGOS VEIN

The absence of the azygos vein is a rare congenital anatomic variation of the azygos venous system resulting from developmental failure of the right supra-cardinal vein (7). In such cases, the hemiazygos and accessory hemiazygos veins play important roles in hemodynamics by draining into the left brachiocephalic vein or the persistent left SVC via the prominent LSIV (Figs. 2, 3) (8). When absent, the azygos vein may not be visible on chest radiography.

Fig. 1. Normal azygos venous system.
The azygos vein arises at the junction between the right ascending lumbar vein and right subcostal vein around the T12 level. It ascends along the right side of the vertebral column and drains into the superior vena cava at the T4–T5 level. The hemiazygos vein, serving as a counterpart to the lower azygos vein, ascends along the left side of the vertebral column, crosses behind the aorta and esophagus, and drains into the azygos vein at the T8–T9 level. At this level, the hemiazygos vein communicates with the accessory hemiazygos vein, which corresponds to the upper azygos vein. The left superior intercostal vein communicates with the accessory hemiazygos vein in approximately 75% of patients, draining into the left brachiocephalic vein.



However, even in approximately 16% of cases in which it is present, it may not be visible on chest radiography (9). Therefore, imaging modalities such as CT are necessary to identify several rare congenital variations and associated anomalies such as a persistent left SVC, double IVC, or left-sided IVC (Figs. 2, 3) (8).

AZYGOS/HEMIAZYGOS CONTINUATION OF THE INFERIOER VENA CAVA

The congenital absence of the intrahepatic IVC with continuation through the azygos or hemiazygos veins is a rare anatomical variation that results from the failure of the primitive segments of the IVC to unite during embryonic development. Discontinuity of the IVC redirects venous blood from the lower body to the dilated azygos venous system, while the hepatic veins drain directly into the right atrium (Fig. 4) (10). This variant is often accompanied by other anomalies such as situs inversus, congenital heart disease, splenic anomalies, and anomalous IVC (11). These anomalies can be grouped as left-sided isomerism (Fig. 5) (12).

Clinically, this congenital variant is associated with a high incidence of deep vein thrombo-

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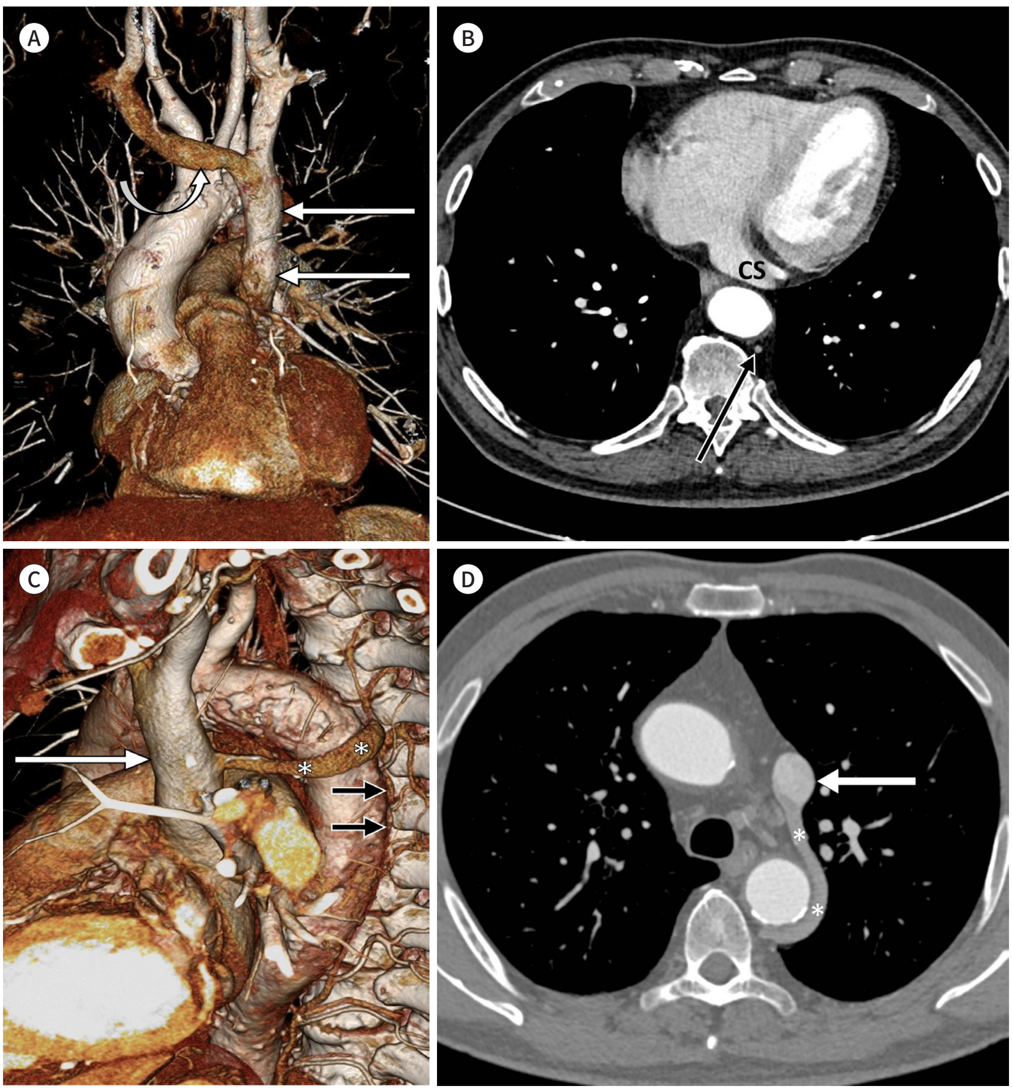
Fig. 2. Absence of azygos vein with isolated persistent left superior vena cava.
A. Anterior view of the three-dimensional volume-rendered image shows the isolated persistent left SVC (arrows). Without the right SVC, the confluence of the right internal jugular and right subclavian vein drains into the persistent left SVC (arrows) via the bridging vein (curved arrow).
B. Axial CT image shows the prominent CS, which drains the persistent left SVC. The hemiazygos vein (arrow) ascends left to the descending thoracic aorta.
C, D. Left cranial view of a three-dimensional volume-rendered image (C) and an oblique axial CT image (D). The hemiazygos vein continues as an accessory hemiazygos vein (black arrows) and drains into the isolated persistent left SVC (white arrows) via the prominent left superior intercostal vein (asterisks).
CS = coronary sinus, SVC = superior vena cava



sis and pulmonary thromboembolism, although it is asymptomatic in most cases (13).

AZYGOS LOBE AND FISSURE

The azygos lobe, a rare congenital variation of the apical segment of the right upper lobe, is found in approximately 1% of anatomical specimens (14). During embryological development, the right posterior cardinal vein migrates aberrantly inside the right upper lobe of the lung instead of over the apex. This results in the formation of the azygos lobe and fissure,

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which indents the lung parenchyma and brings the parietal and visceral pleura into the lungs. The azygos fissure then holds the azygos arch deep inside. The azygos lobe is not a genuine separate lobe but rather a segment supplied by the bronchovascular branches of the apical or

Fig. 3. Absence of azygos vein with left-sided double inferior vena cava and a persistent left superior vena cava.
A. At the level of the infrarenal IVC, the axial CT image shows left-sided double IVC (asterisks) positioned left to the abdominal Ao.
B. At the level of the renal veins, the axial CT image shows left-sided double IVC becoming a single left-sided IVC (asterisk). The bilateral renal veins (arrows) drain into the left-sided IVC.
C. At the aortic hiatus level, the axial CT image shows the left-sided IVC (asterisk) continuing as the hemiazygos vein. There is no intrahepatic IVC.
D-F. Axial (D, E) and coronal (F) CT images show an enlarged hemiazygos vein (asterisks) ascending along the left side of the descending thoracic Ao, continuing as an accessory hemiazygos vein, and draining into the persistent left SVC (white arrows) via the LSIV (curved arrow). Note the absence of the azygos vein that normally drains into the right SVC (blank arrows).
G. Coronal CT image shows a double SVC without a bridging vein. The persistent left SVC (white arrows) drains into the right atrium through the coronary sinus. Note the right SVC (blank arrows).
Ao = aorta, IVC = inferior vena cava, LSIV = left superior intercostal vein, SVC = superior vena cava

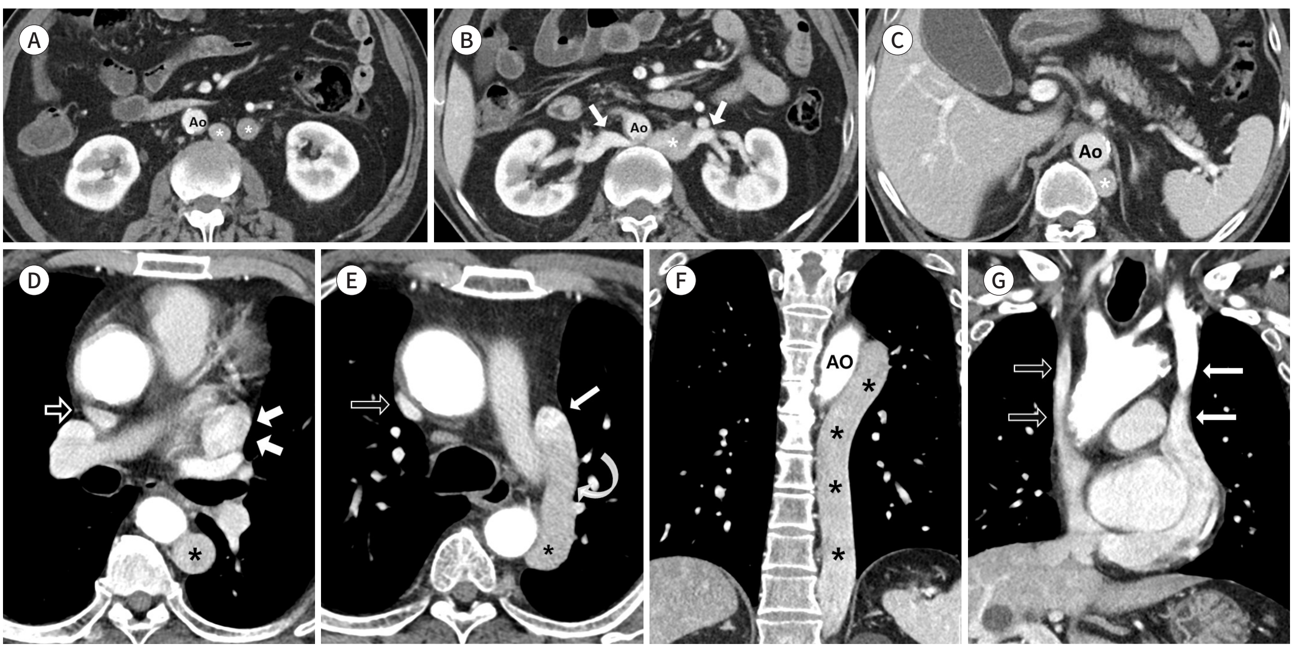

Fig. 4. Azygos continuation of inferior vena cava.
A. Axial CT image shows the engorged AV without the intrahepatic IVC.
B, C. Coronal (B) and axial (C) CT images show that the IVC continues as a diffusely engorged AV (arrows) and drains into the SVC.
AV = azygos vein, IVC = inferior vena cava, SVC = superior vena cava

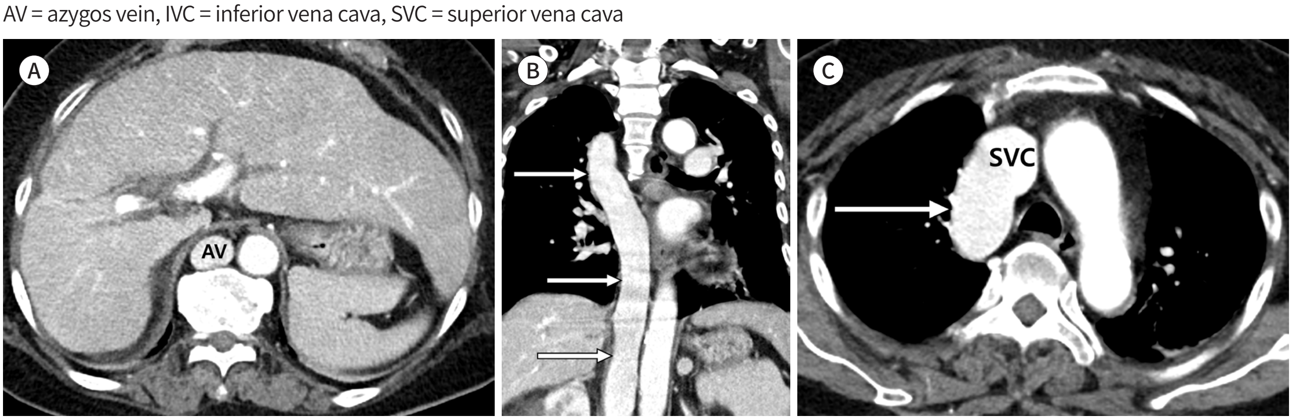

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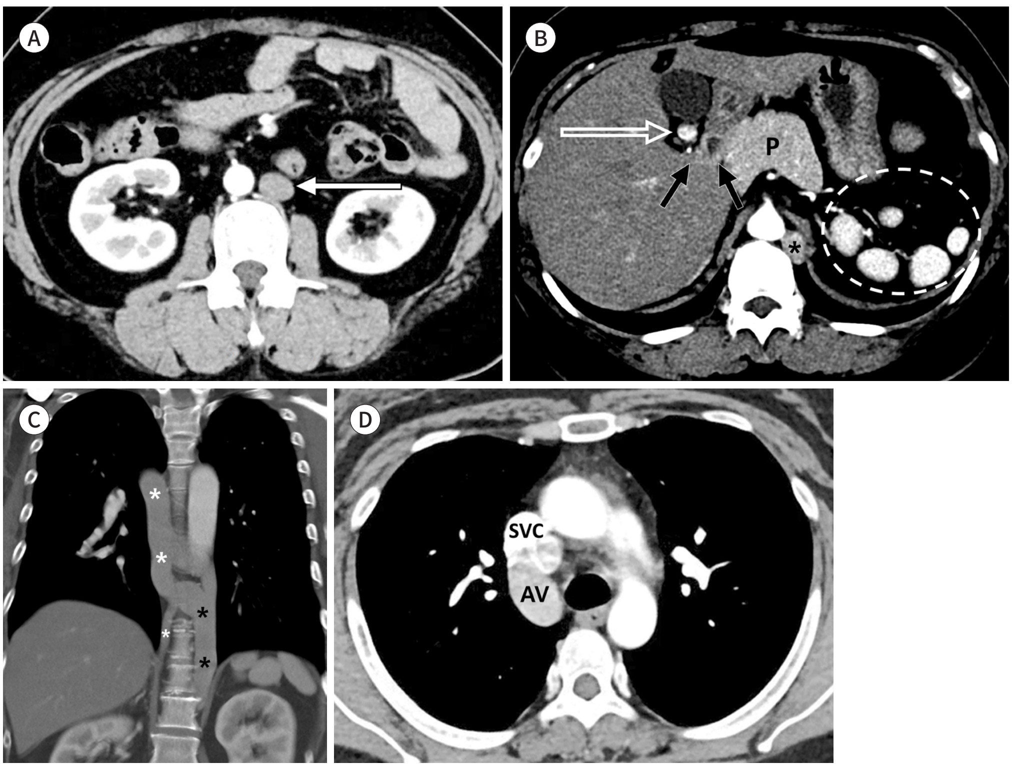
Fig. 5. Hemiazygos and azygos continuation of the left-sided inferior vena cava (polysplenia syndrome).
A, B. Axial CT images show that the left-sided IVC (white arrow) continues as the hemiazygos vein (asterisk) in the absence of the intrahepatic IVC. Small multiple splenunculi (dashed-line circles) are noted. A congenitally short pancreas (P) and preduodenal portal vein (blank arrow) located anterior to the duodenal bulb (black arrows) are also noted.
C, D. Coronal maximum intensity projection image (C) and axial CT image (D) show the enlarged hemiazygos vein (black asterisks) draining into the enlarged AV (white asterisks) and finally into the SVC.
AV = azygos vein, IVC = inferior vena cava, SVC = superior vena cava



posterior segments of the right upper lobe (14).

On chest radiographs, the azygos fissure appears as a fine line and the azygos arch appears as a right paratracheal opacity (Fig. 6). CT revealed that the azygos lobe was located deep behind the trachea and adjacent to the esophagus. The tubular azygos arch crosses the right upper lobe and terminates at the SVC or in the right brachiocephalic vein (Fig. 7).

This abnormality can mimic several pathological conditions such as bullae, abscesses, or lung masses (15). In the clinical setting, the azygos lobe generally shows no definite pathology; however, spontaneous pneumothorax rarely occurs. In the surgical setting, specific concerns are necessary to avoid the risk of vasculonervous injury during thoracic surgery because the phrenic nerve can become entrapped in the azygos fissure (16).

IDIOPATHIC AZYGOS VEIN ANEURYSM

Dilation of the azygos vein can be caused by various conditions; however, idiopathic aneurysms are extremely rare and typically confined to the azygos arch. In such cases, only the azygos arch shows aneurysmal dilatation, while the azygos vein below the midthoracic level appears normal (17). The exact etiology of idiopathic azygos vein aneurysms (AVAs) remains

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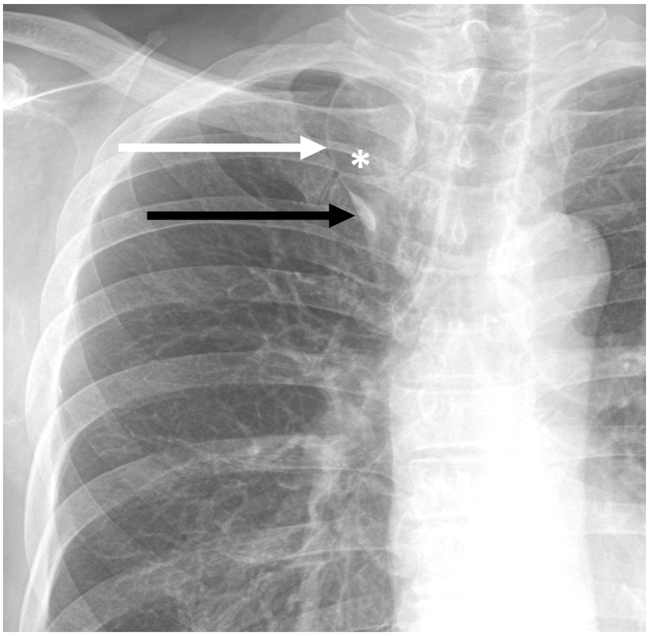
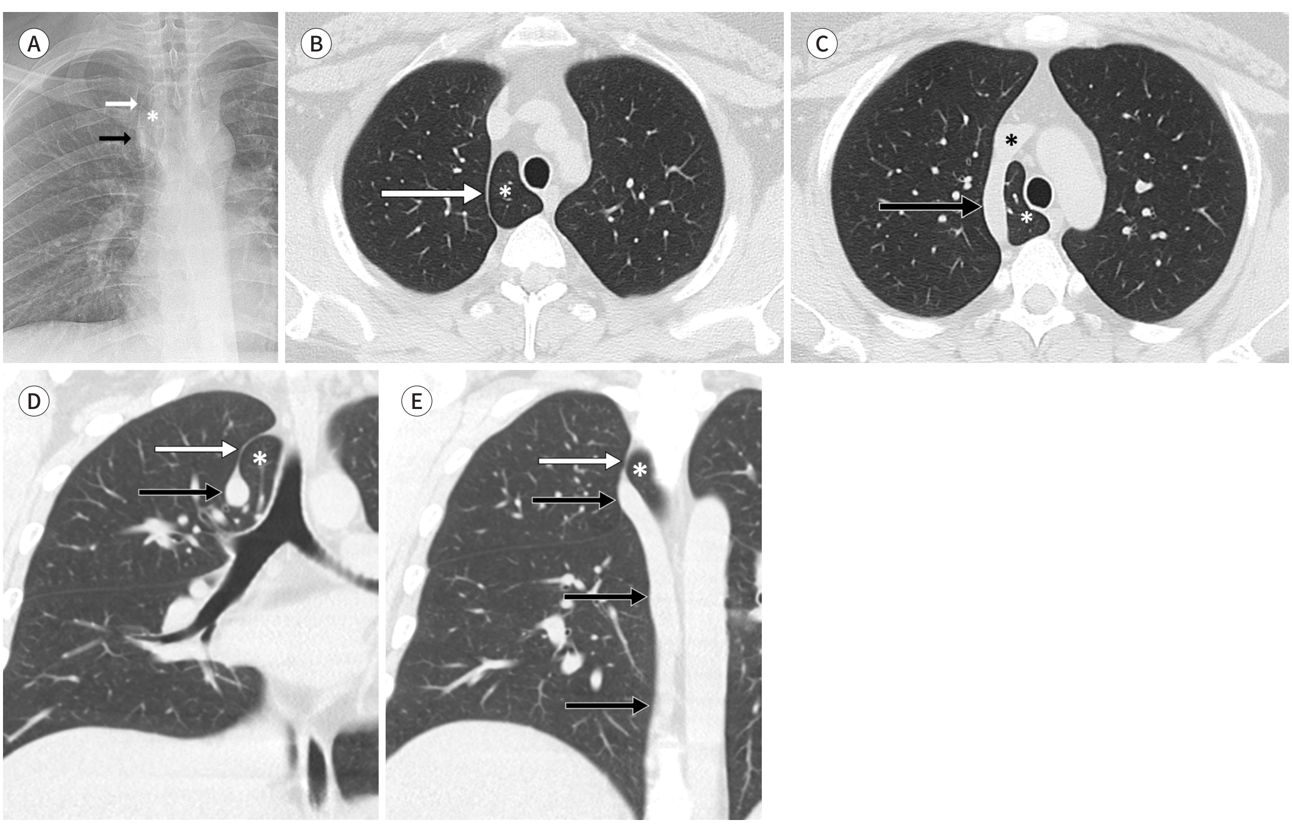


Fig. 6. Azygos lobe and fissure.
A Chest PA shows the azygos fissure (white arrow) as a fine line and the tubular azygos arch (black arrow) in the right upper lobe. The azygos lobe (asterisk) is incompletely separated from the right upper lung.

Fig. 7. Azygos lobe and fissure.
A-C. Chest PA (A) and axial CT images (B, C) show the azygos lobe (white asterisks) demarcated by the azygos fissure (white arrows). The azygos vein (black arrows) arches anteriorly, crosses the right upper lobe, and drains into the superior vena cava (black asterisk).
D, E. Coronal CT images show the relationship between the azygos fissure (white arrows), azygos vein (black arrows), and azygos lobe (asterisks).



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unknown; however, it is believed to be congenital. Before making a diagnosis, other possible causes contributing to dilatation of the azygos vein should be excluded.

AVA are typically asymptomatic and often detected incidentally during routine chest radiography or CT. They can present as a right paratracheal mass (Fig. 8) or posterior mediastinal mass (18). On contrast-enhanced CT, AVA appear as well-defined mediastinal masses that are homogeneously enhanced in the venous phase (Fig. 8).

Although AVA are typically asymptomatic, they occasionally cause dyspnea, dysphagia, and chest discomfort or pain associated with mass effects or pulmonary thromboembolism (19). Both complete and partial thromboses of the AVA have been reported and may predispose patients to pulmonary embolism. Thrombus formation within the AVA has been hypothesized to result from sluggish flow and inflammation, which allow the intraluminal thrombus to flow into the pulmonary arteries (19, 20).

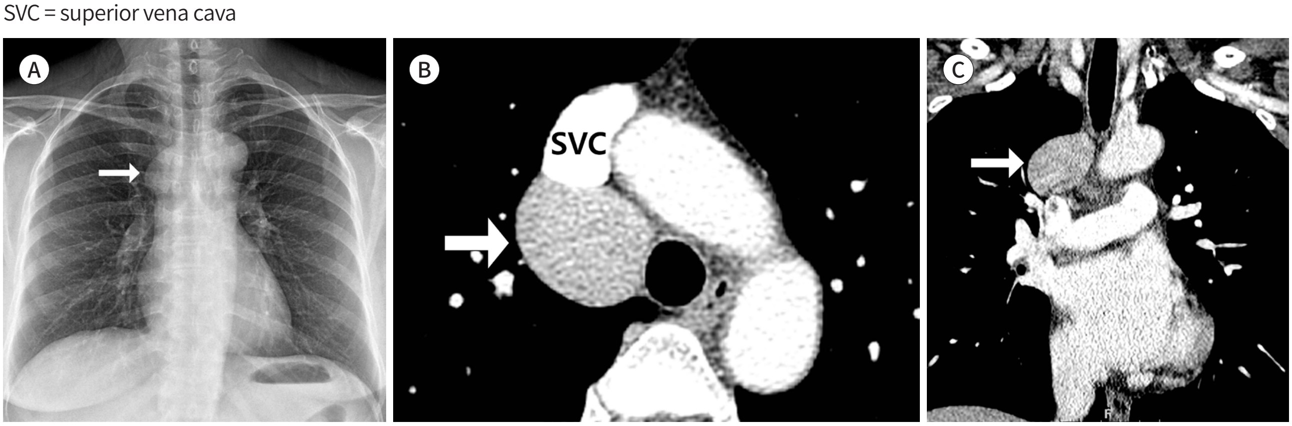
ACQUIRED STRUCTURAL CHANGES

The azygos venous system can show acquired structural changes when portal venous pressure increases or the SVC or IVC is compromised. The resulting hemodynamic alterations typically lead to dilation of the azygos venous system, which serves as a crucial shunt. Awareness of the causative pathology or related findings is essential for radiologists to facilitate an accurate diagnosis.

LIVER CIRRHOSIS WITH A PROMINENT AZYGOS VEIN AS A PORTOSYSTEMIC COLLATERAL

Liver cirrhosis often results in changes in pH and other complications. One hallmark feature of liver cirrhosis is the development of portosystemic collaterals, which alleviate the high portal pressure. In patients with liver cirrhosis, the azygos venous system is frequently dilated as a component of the portosystemic collaterals.

Fig. 8. Idiopathic azygos vein aneurysm.
A. Chest PA shows the enlarged azygos vein aneurysm (arrow) presenting as a right paratracheal mass.
B, C. Axial (B) and coronal (C) contrast-enhanced CT images show a well-defined mediastinal mass (arrows) enhanced homogeneously in the venous phase, which is an aneurysm in the azygos arch draining into the SVC.
Courtesy of Hye Sun Hwang of Samsung Medical Center.
SVC = superior vena cava



Most frequently, the azygos or hemiazygos veins are dilated in combination with other portosystemic collaterals such as esophageal or paraesophageal varices (Fig. 9). Varices located below the mid-esophagus drain into the SVC through the prominent azygos venous system (Fig. 9), whereas those extending into the upper esophagus drain into the subclavian or brachiocephalic veins (21).

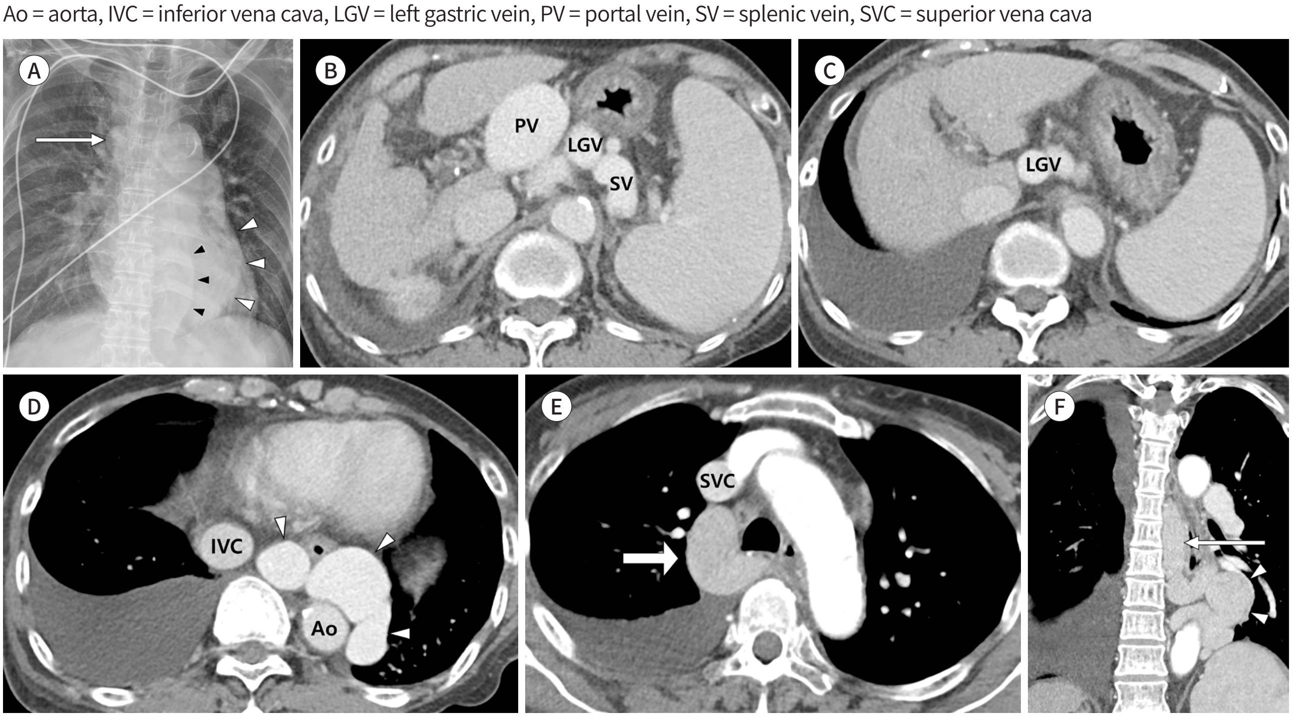
Enlarged portosystemic collaterals and azygos venous system can appear as a mass or thickening on chest radiography mimicking a paraesophageal or paratracheal mass. Occasionally, additional imaging or invasive procedures are required to confirm the diagnosis (Fig. 9).

A direct spontaneous portoazygos shunt in adults is rare and typically occurs between the posterior aspect of the main portal vein and the azygos vein along the right aspect of the thoracolumbar vertebrae (22). Clinically, a portoazygos shunt may be associated with hepatic encephalopathy (22).

BUDD-CHIARI SYNDROME

BCS is a rare liver disease characterized by occlusion of the hepatic venous outflow at the level of the large hepatic vein or the extrahepatic segment of the IVC, which leads to portal hypertension.

Fig. 9. Liver cirrhosis with a prominent azygos-hemiazygos vein as portosystemic collateral.
A. Chest PA shows an enlarged azygos arch (arrow) as a right paratracheal mass. The retrocardiac mass shadows represent the border of the engorged paraesophageal varices (white arrowheads) and bulging of the descending thoracic Ao line (black arrowheads), in a patient with underlying liver cirrhosis.
B, C. Axial CT images show enlarged PV, LGV, and SV. Note the cirrhotic figure of the liver and the obliteration of the PV that ends at the level of the hepatic hilum.
D-F. Axial (D, E) and coronal (F) CT images show markedly engorged paresophageal varices (arrowheads) draining into the prominent hemiazygos vein (arrows) at the mid-esophageal level.
Ao = aorta, IVC = inferior vena cava, LGV = left gastric vein, PV = portal vein, SV = splenic vein, SVC = superior vena cava



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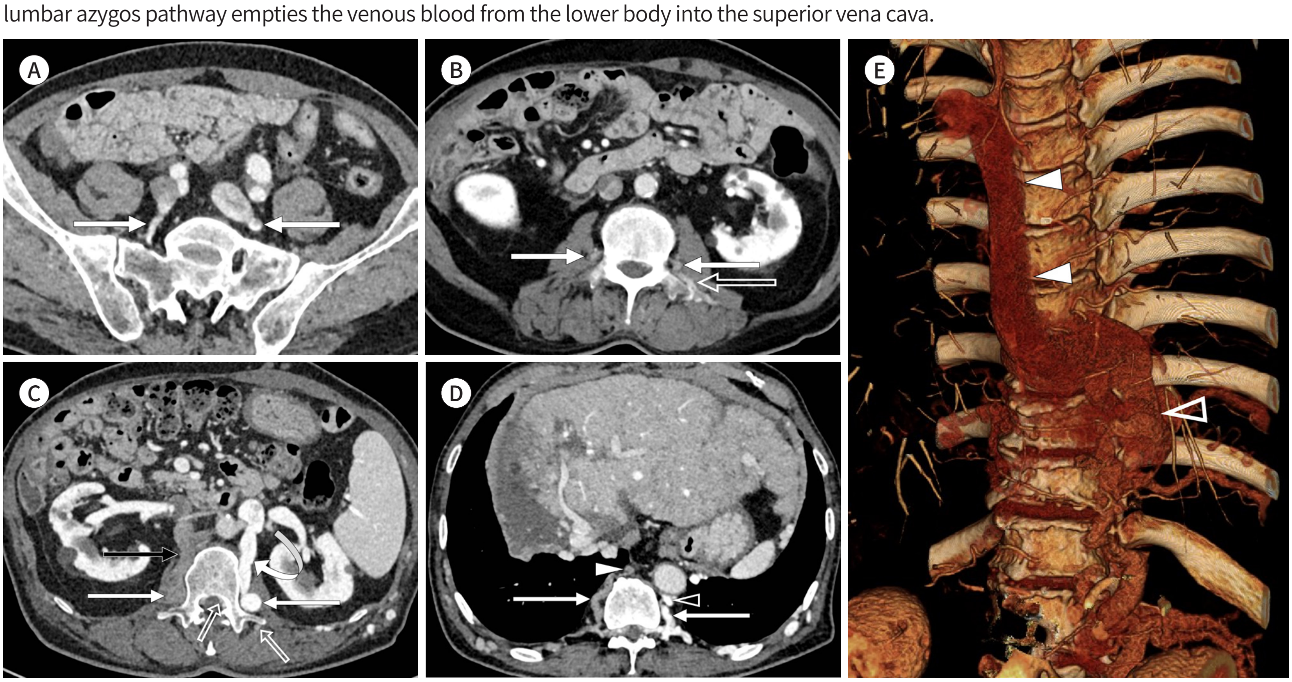
In Western countries, the most common cause of BCS is thrombotic obstruction of the hepatic vein or IVC caused by systemic disease or malignant tumors, whereas primary membranous or segmental obstruction of the IVC is more common in Asian countries (23).

In BCS, similar to liver cirrhosis, various extrahepatic collateral pathways develop to bypass the obstruction and reduce the portal pressure (24). However, the locations of these pathways may differ from those observed in patients with liver cirrhosis. The vertebrolumbar azygos pathway is the most common extrahepatic collateral pathway in BCS. In this pathway, the venous flow of the IVC reverses to the common iliac vein, continues through the retroperitoneal collateral veins, including the ascending lumbar vein and vertebral venous plexus, and finally anastomoses with the azygo/hemiazygos venous system (Fig. 10) (23, 25). Other common extrahepatic collateral pathways include the left renal-hemiazygos, superficial abdominal wall, intrahepatic collaterals, and inferior phrenic-pericardiophrenic pathways (23).

COMPROMISE OF SVC/IVC

The SVC and IVC are the major vessels that receive venous blood from the systemic circulation and return it to the heart. SVC or IVC obstruction is typically an acquired condition caused by thrombosis, direct tumor invasion, or extrinsic compression (26). When the SVC or IVC becomes completely or partially obstructed, various collateral pathways develop to preserve the

Fig. 10. Vertebrolumbar-azygos collateral pathway in a patient with Budd-Chiari syndrome.
A. Axial CT image shows a pair of ascending lumbar veins (arrows) arising from the posterior aspect of the bilateral common iliac veins. These ascending lumbar veins drain the reverse venous flow from the inferior vena cava.
B, C. Axial CT images show bilateral dilated ascending lumbar veins (white arrows) between the psoas muscle and the lumbar vertebra communicating with multiple engorged lumbar veins (black arrow), a prominent vertebral venous plexus (blank arrows), and a branch of the renal vein (curved arrow).
D, E. On the axial CT image (D) and three-dimensional volume–rendered left anterior oblique view image (E), the prominent retroperitoneal collaterals (white arrows) continue as dilated azygos (arrowheads) and hemiazygos veins (blank arrowheads). Finally, the vertebrolumbar azygos pathway empties the venous blood from the lower body into the superior vena cava.

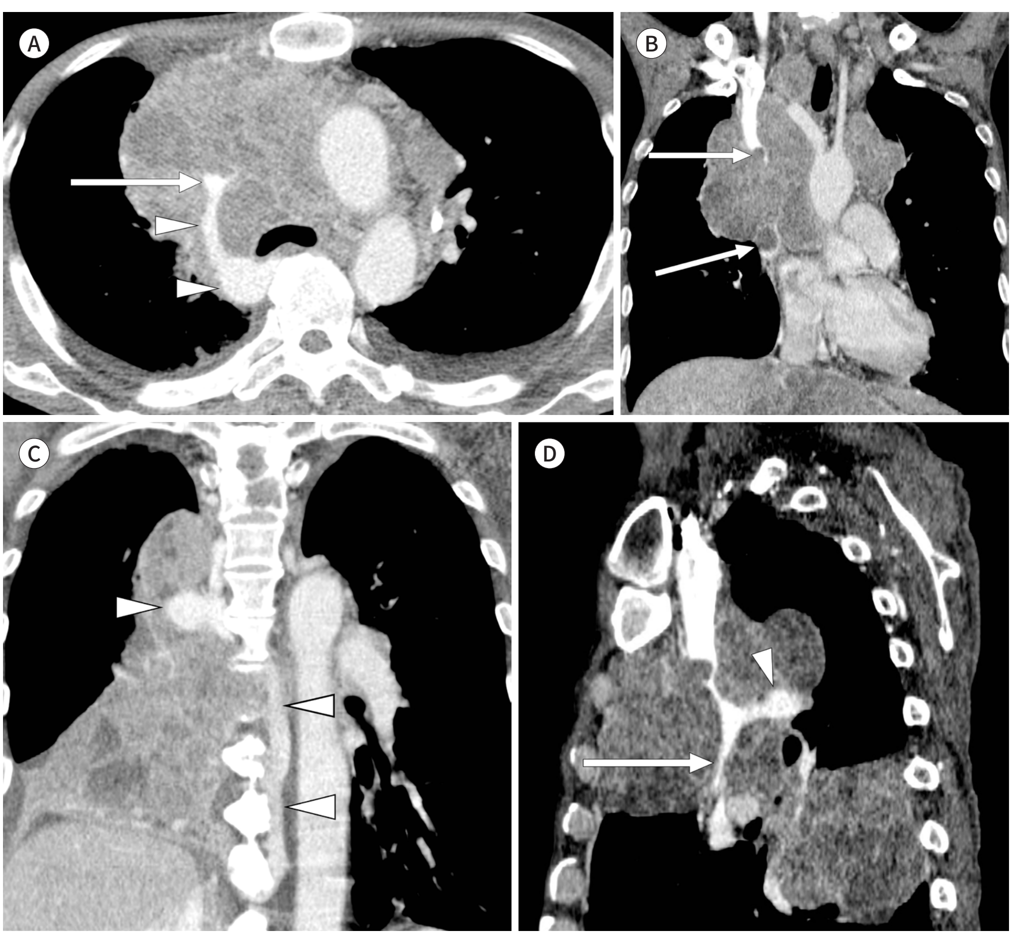


venous return to the heart. The azygos-hemiazygos pathway, a major collateral pathway for decompression of an SVC or IVC obstruction, includes the azygos, hemiazygos, intercostal, and lumbar veins. Other common collateral pathways include the internal and external mammary, lateral thoracic, and vertebral pathways (27). Location of the obstruction site is crucial for determining collateral pathway type (26, 28).

The most common cause of SVC obstruction is metastasis or mediastinal malignancy (Fig. 11), followed by fibrosing mediastinitis, benign tumors, and sarcoidosis (27). The incidence of iatrogenic causes such as catheter-associated thrombosis has increased with the increased use of intravascular catheters (29). Unless the obstruction involves the azygos vein insertion site of the SVC, the azygos-hemiazygos pathway predominates with or without other collaterals. Based on obstruction site level and dominant collateral pathway, the azygos vein can flow in the anterograde or retrograde direction (5, 27).

Thromboembolisms of the lower extremities or deep pelvic veins are the leading causes of

Fig. 11. Partial obstruction of superior vena cava due to lung cancer with metastatic lymphadenopathy.
A-C. Advanced lung cancer and conglomerated metastatic lymphadenopathy in the mediastinum. Axial (A) and coronal (B, C) CT images show luminal narrowing of the superior vena cava (arrows) due to extrinsic compression and possible direct tumor invasion. A dilated azygos venous system (arrowheads) is noted.
D. Sagittal CT image shows an enlarged azygos vein (arrowhead) distal to the impending obstruction site (arrow). In the present case, the flow in the azygos vein was retrograde.



IVC obstruction. IVC involvement in neoplasms can also occur. Secondary involvement is more common in abdominal malignancies (30, 31) than in primary tumors such as leiomyoma or leiomyosarcoma. Similar to SVC obstruction, the azygos-hemiazygos pathway is primary, with or without other collateral pathways. BCS is a type of IVC obstruction; therefore, the vertebrolumbar azygos pathway can function as a shunt along with other causes.

CONCLUSION

The wide variety of imaging findings of the azygos venous system results from complex embryological development or acquired pathological conditions. Although most of these variations are asymptomatic, their recognition is crucial to avoiding misdiagnosis. Moreover, understanding the etiology, including hemodynamic changes, is essential for planning further treatment and surgical interventions.

Author Contributions

Writing—original draft, K.H.N.; and writing—review & editing, all authors.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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REFERENCES

1. Demos TC, Posniak HV, Pierce KL, Olson MC, Muscato M. Venous anomalies of the thorax. *AJR Am J Roentgenol* 2004;182:1139-1150
2. Tatar I, Denk CC, Celik HH, Oto A, Karaosmanoglu DA, Ozdemir BM, et al. Anatomy of the azygos vein examined by computerized tomography imaging. *Saudi Med J* 2008;29:1585-1588
3. Dudiak CM, Olson MC, Posniak HV. CT evaluation of congenital and acquired abnormalities of the azygos system. *Radiographics* 1991;11:233-246
4. Shin DS, Sandstrom CK, Ingraham CR, Monroe EJ, Johnson GE. The inferior vena cava: a pictorial review of embryology, anatomy, pathology, and interventions. *Abdom Radiol (NY)* 2019;44:2511-2527
5. Piciucchi S, Barone D, Sanna S, Dubini A, Goodman LR, Oboldi D, et al. The azygos vein pathway: an overview from anatomical variations to pathological changes. *Insights Imaging* 2014;5:619-628
6. Ball JB Jr, Proto AV. The variable appearance of the left superior intercostal vein. *Radiology* 1982;144:445-452
7. Fröber R, Eichhorn KH, Schleußner E, Schlembach D. Heterotaxy syndrome: an embryologic study. *Ann Clin Lab Res* 2016;4:1
8. Arslan G, Cubuk M, Ozkaynak C, Sindel T, Lüleci E. Absence of the azygos vein. *Clin Imaging* 2000;24:157-158
9. Milne EN, Pistolesi M, Miniati M, Giuntini C. The vascular pedicle of the heart and the vena azygos. Part I: the normal subject. *Radiology* 1984;152:1-8
10. Blanchard DG, Sobel JL, Hope J, Raisinghani A, Keramati S, DeMaria AN. Infrahepatic interruption of the inferior vena cava with azygos continuation: a potential mimicker of aortic pathology. *J Am Soc Echocardiogr* 1998;11:1078-1083
11. Vaughan TJ, Hawkins IF Jr, Elliott LP. Diagnosis of polysplenia syndrome. *Radiology* 1971;101:511-518
12. Applegate KE, Goske MJ, Pierce G, Murphy D. Situs revisited: imaging of the heterotaxy syndrome. *Radio-*

graphics 1999;19:837-852; discussion 853-854
13. Del Prete A, Cavaliere C, Di Pietto F, De Ritis R. Situs inversus with levocardia, infrahepatic interruption of the inferior vena cava, and azygos continuation: a case report. *Surg Radiol Anat* 2016;38:369-371
14. Mata J, Cáceres J, Alegret X, Coscojuela P, De Marcos JA. Imaging of the azygos lobe: normal anatomy and variations. *AJR Am J Roentgenol* 1991;156:931-937
15. Akhtar J, Lal A, Martin KB, Popkin J. Azygos lobe: a rare cause of right paratracheal opacity. *Respir Med Case Rep* 2018;23:136-137
16. Ndiaye A, Ndiaye NB, Ndiaye A, Diop M, Ndoye JM, Dia A. The azygos lobe: an unusual anatomical observation with pathological and surgical implications. *Anat Sci Int* 2012;87:174-178
17. Ko SF, Huang CC, Lin JW, Lu HI, Kung CT, Ng SH, et al. Imaging features and outcomes in 10 cases of idiopathic azygos vein aneurysm. *Ann Thorac Surg* 2014;97:873-878
18. Savu C, Melinte A, Balescu I, Bacalbasa N. Azygos vein aneurysm mimicking a mediastinal mass. *In Vivo* 2020; 34:2135-2140
19. Tujo CA, Jesinger RA. Azygous vein aneurysm (AVA): a case report. *J Clin Diagn Res* 2017;11:TD03-TD05
20. Yang JY, Kim DH, Lee JH, Suk EH. Evaluating a thrombosed azygous vein aneurysm combined with pulmonary arterial thromboembolism by ECG-gated multidetector CT: a case report. *Korean J Radiol* 2011;12:754-756
21. Pillai AK, Andring B, Patel A, Trimmer C, Kalva SP. Portal hypertension: a review of portosystemic collateral pathways and endovascular interventions. *Clin Radiol* 2015;70:1047-1059
22. Gebrael J, Yu H, Hyslop WB. Spontaneous portoazygos shunt in a patient with portal hypertension. *J Radiol Case Rep* 2013;7:32-36
23. Cho OK, Koo JH, Kim YS, Rhim HC, Koh BH, Seo HS. Collateral pathways in Budd-Chiari syndrome: CT and venographic correlation. *AJR Am J Roentgenol* 1996;167:1163-1167
24. Cai SF, Gai YH, Liu QW. Computed tomography angiography manifestations of collateral circulations in Budd-Chiari syndrome. *Exp Ther Med* 2015;9:399-404
25. Erden A. Budd-Chiari syndrome: a review of imaging findings. *Eur J Radiol* 2007;61:44-56
26. Dahan H, Arrivé L, Monnier-Cholley L, Le Hir P, Zins M, Tubiana JM. Cavoportal collateral pathways in vena cava obstruction: imaging features. *AJR Am J Roentgenol* 1998;171:1405-1411
27. Kapur S, Paik E, Rezaei A, Vu DN. Where there is blood, there is a way: unusual collateral vessels in superior and inferior vena cava obstruction. *Radiographics* 2010;30:67-78
28. Berk RN. Dilatation of the left superior intercostal vein in the plain-film diagnosis of chronic superior vena caval obstruction. *Radiology* 1964;83:419-423
29. Picascia O, Fiorini V, Vitale G, Quassone P, Scognamiglio M, Ferrandino G, et al. Iatrogenic superior vena cava syndrome with concomitant deep vein thrombosis of azygos and hemiazygos veins. *Radiol Case Rep* 2021;16:1895-1898
30. Smillie RP, Shetty M, Boyer AC, Madrazo B, Jafri SZ. Imaging evaluation of the inferior vena cava. *Radiographics* 2015;35:578-592
31. Vallakati A, Chandra PA, Frankel R, Shani J. Intra-atrial tumor thrombi secondary to hepatocellular carcinoma responding to chemotherapy. *N Am J Med Sci* 2011;3:435-437

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기정맥계의 CT 소견: 선천변이 및 후천적 구조 변화

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기정맥계는 후방 흉부의 중요한 부속 정맥이며 측부순환으로서 중대한 역할을 한다. 그러나, 그 중요성에도 불구하고 임상적 혹은 영상의학적으로 종종 간과된다. 본 임상화보에서는, 기정맥계의 정상 해부학에 대해 알아보고, 기정맥계에서 볼 수 있는 다양한 선천 변이와 후천적 질환에 따른 구조 변화의 CT 소견에 대하여 검토하고자 한다.

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