

# Imaging of spaces of neck and mediastinum by endoscopic ultrasound

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## ABSTRACT

Endoscopic ultrasound (EUS) of the mediastinum was pioneered by gastroenterologists, and it was taken up by pulmonologists when the smaller-diameter endobronchial ultrasound (EBUS) scope was designed after a few years. The pulmonologists' approach remained largely confined to entry from the trachea, but they soon realized that the esophagus was an alternative route of entry by the EBUS scope. The new generations of interventionists are facing the challenge of learning two techniques (EUS and EBUS) from two routes (esophagus and trachea). The International Association for the Study of Lung Cancer (IASLC) proposed a classification of mediastinal lymph nodes at different stations that lie within the boundaries of specific spaces. These interventionists need clear definitions of landmarks and clear techniques to identify the spaces. There are enough descriptions of spaces of the neck and the mediastinum in the literature, yet the topic mentioned above has never been discussed separately. The anatomical structures, landmarks, and boundaries of spaces will be important to interventionists in the near future during performances of endosonography. This article combines the baseline anatomy of the spaces with the actual imaging during EUS.

**KEY WORDS:** Endoscopic ultrasound, mediastinum, neck, spaces

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## BACKGROUND

The neck and the mediastinum contain a number of connective tissue spaces that are continuous with each other. These spaces have no universally accepted nomenclature or boundaries.<sup>[1]</sup> The available descriptions of spaces in the neck are generally with relation to layers of fascia.<sup>[2]</sup> The mediastinum has no limiting fascial layers like the neck, and the spaces of mediastinum are generally described with relation to the trachea.<sup>[3]</sup> Clinicians need to know about these spaces as they are potential pathways for the spread of disease and contain normal, regional, or metastatic lymph nodes.<sup>[4,5]</sup> Each malignancy has its unique first echelon and pattern of spread to different nodal stations.<sup>[6]</sup> Proper staging of diseased lymph nodes at different stations is possible by computed tomography (CT), positron emission tomography (PET), and PET-CT.<sup>[4,7]</sup> Ultrasonography (US) also assumes importance

in the routine diagnosis, treatment, and follow-up of diseases of the head, neck, and chest.<sup>[8-11]</sup> Imaging of hollow organs by endoscopic ultrasound (EUS) and EUS-guided fine-needle aspiration cytology (FNAC) has improved accuracy in the assessment of local lymph node metastases in malignancies of the neck, esophagus, and lung when compared with CT.<sup>[12-14]</sup> Currently, EUS is increasingly used in the evaluation of metastatic disease, posttreatment assessment, and the detection of recurrent disease, and it offers a distinct advantage in EUS-FNAC of lymph nodes or masses that are not accessible to CT.<sup>[15-17]</sup>

Anatomical knowledge of the spaces of the neck and mediastinum can help in EUS examination from the pharynx and esophagus. This article describes the normal EUS anatomy of the neck and mediastinum.

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	<b>DOI:</b> 10.4103/0970-2113.180866

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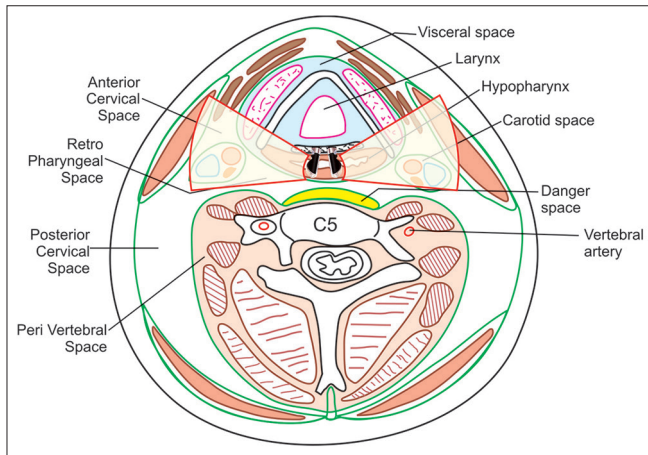
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**How to cite this article:** Sharma M, Pathak A, Shoukat A, Somani P. Imaging of spaces of neck and mediastinum by endoscopic ultrasound. Lung India 2016;33:292-305.

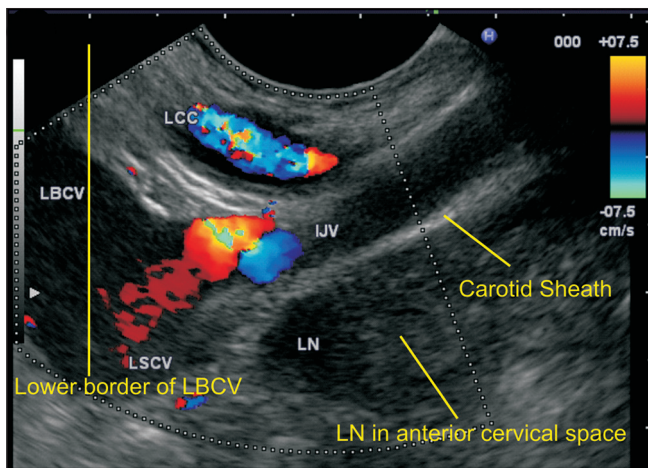
**PROCEDURE**

**Applied anatomy of spaces of neck**

The pharynx extends from the base of the skull to the level of cricoid cartilage (C6), and the esophagus extends from the lower margin of cricoid cartilage to the abdomen (T11) [Figure 1]. The neck is generally subdivided into the suprahyoid and infrahyoid regions by the hyoid bone. The deep neck spaces (submandibular space, sublingual space, parotid space, parapharyngeal space, and masticator space) are present only in the suprahyoid region. Visceral space, anterior cervical space, and posterior cervical space are present only in the infrahyoid region.<sup>[2]</sup> The carotid, retropharyngeal, perivertebral, and danger spaces extend up to the base of the skull and are present in both the suprahyoid and infrahyoid



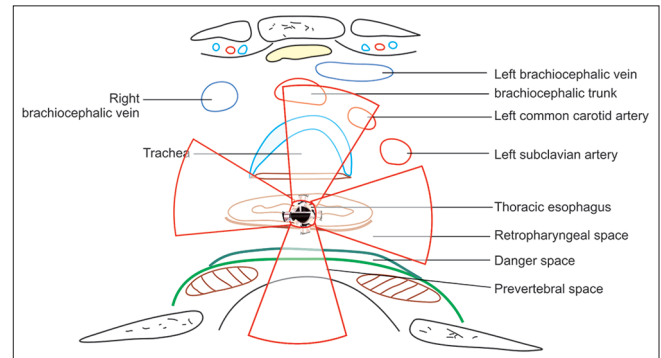
**Figure 1:** The spaces in the neck are formed from the three layers of cervical fascia, i.e., a superficial, a pretracheal, and a prevertebral layer. The superficial layer surrounds all the important structures in the neck, the prevertebral layer surrounds the vertebral column and the nearby muscles, and the pretracheal layer forms a visceral compartment around the trachea and esophagus. On either side of the cervical esophagus are the carotid spaces, and behind are the retropharyngeal and perivertebral spaces. The anterior and posterior cervical space lie anterior and posterior to the carotid space



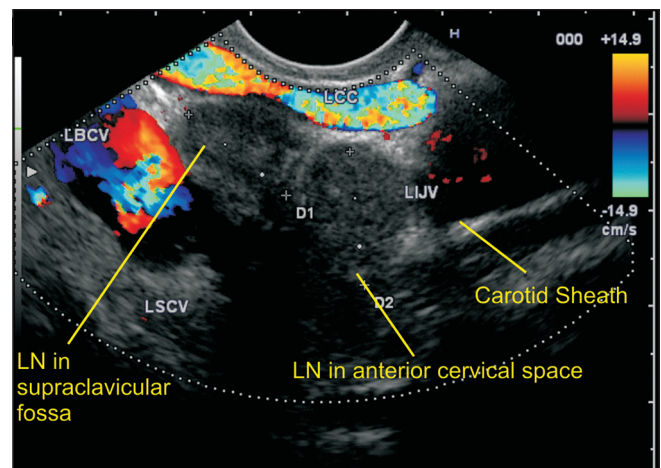
**Figure 3:** A lymph node is seen in the lowermost part of the supraclavicular fossa belonging to the lower jugular group. This lies in the anterior cervical space anterior to the carotid sheath

regions [Figure 1]. The infrahyoid region of the neck can be evaluated through the anterior lateral or posterior wall of the pharynx and esophagus by EUS [Figure 2].

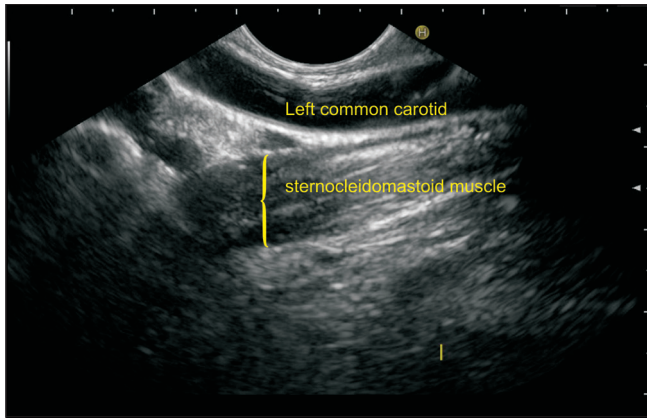
1. The anterior cervical space is a paired space lying lateral to the visceral space and anterior to the carotid space in the anterior triangle of the neck deep to the sternocleidomastoid muscle [Figures 3 and 4]
2. The posterior cervical space is a paired, adipose-tissue space located posterior to the sternocleidomastoid muscle in the lower part of the posterior triangle (supraclavicular triangle) of the neck [Figures 5–8]
3. The visceral space is a median space delimited anterolaterally by the anterior cervical space, posterolaterally by the carotid space, and posteriorly by the retropharyngeal space [Figures 9 and 10]<sup>[18]</sup>
4. The carotid space is a paired space containing the main neurovascular bundle of the neck including the common carotid artery, the internal carotid artery, and the internal jugular vein [Figures 11–13]
5. The retropharyngeal (retroesophageal space) is a median space present behind the pharynx and cervical



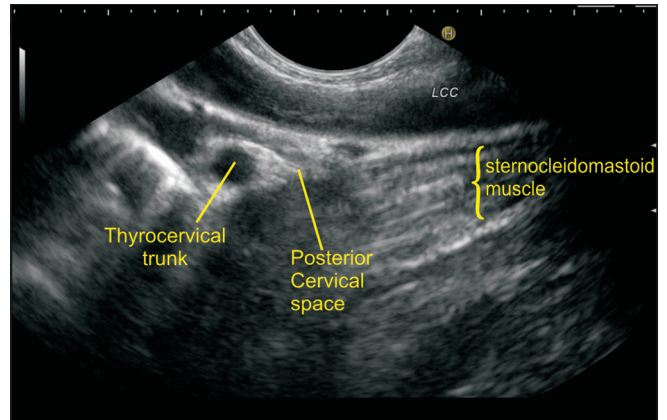
**Figure 2:** EUS through the anterior and lateral wall of the esophagus allows examination of visceral, carotid, anterior cervical, and posterior cervical spaces. EUS through the posterior esophageal wall allows the examination of retropharyngeal (retroesophageal), danger, and prevertebral spaces



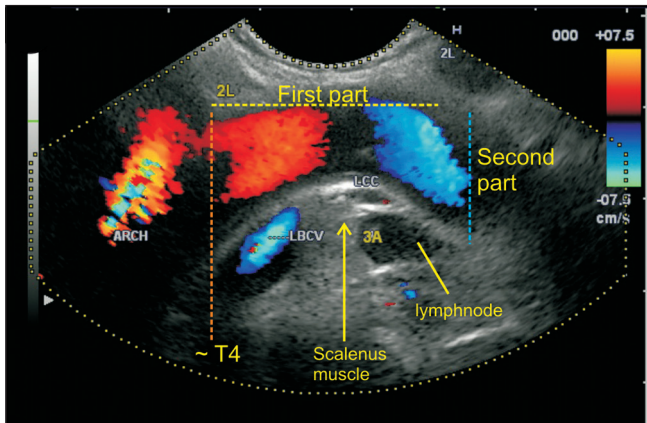
**Figure 4:** A lymph node is seen in the lowermost part of the neck belonging to the lower jugular group of lymph nodes both anterior and posterior to the carotid sheath. The lymph node in the supraclavicular fossa lies in the posterior cervical space



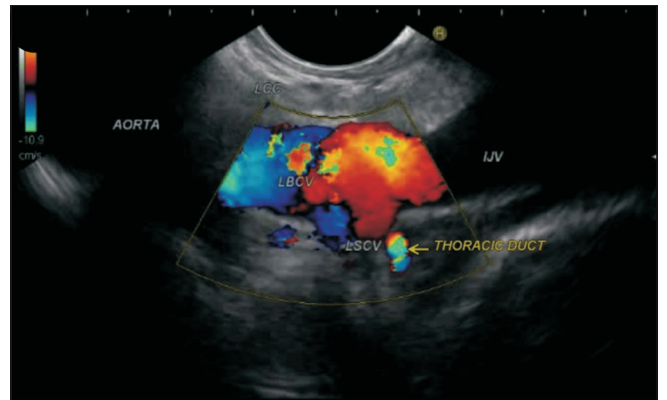
**Figure 5:** The left common carotid artery lies in the carotid sheath in anterolateral relation to the esophagus, and the sternocleidomastoid muscle lies beyond the carotid sheath



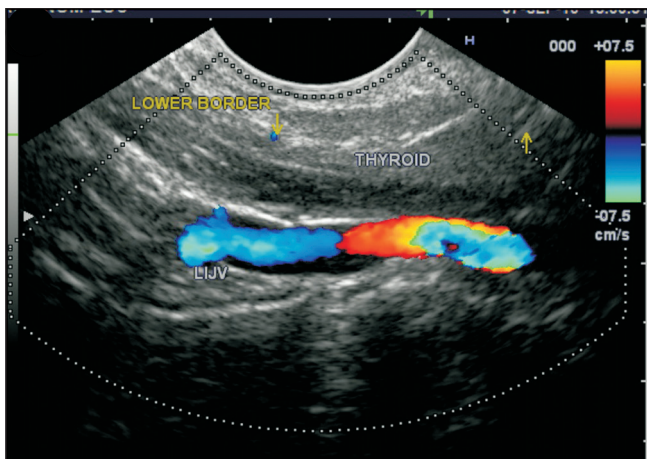
**Figure 6:** The thyrocervical trunk is a branch of the first portion of the subclavian artery arising between the origin of the subclavian artery and the inner border of the scalenus anterior muscle. The thyrocervical trunk is located in the supraclavicular fossa in the posterior cervical space surrounded by hyperechoic adipose tissue



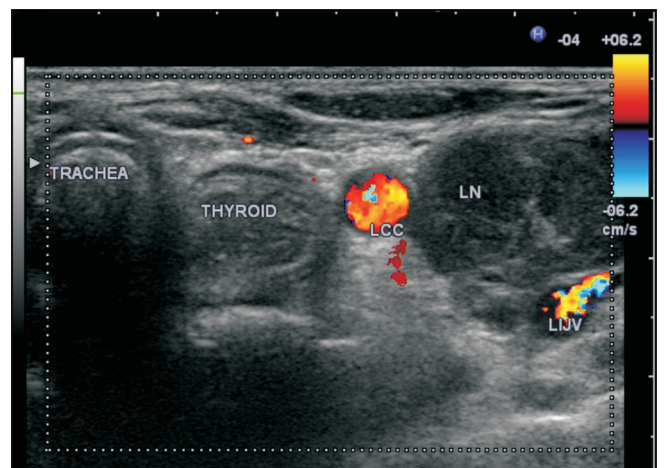
**Figure 7:** The left subclavian artery arises from the arch of the aorta at the level of the T4 vertebra (orange dotted line). The scalenus anterior (SA) muscle (yellow arrow) divides this artery into three parts. The first part extends from the origin to the medial border of the SA and ascends in the superior mediastinal cavity to the root of the neck (yellow dotted line). The second part lies behind the SA, forms the highest part of the arch, and arches laterally (blue dotted line). A lymph node belonging to station 3a (by IASLC classification) is seen lying in the prevascular space



**Figure 8:** The thoracic duct is seen joining the junction of the left brachiocephalic vein with the left subclavian vein in the posterior cervical space



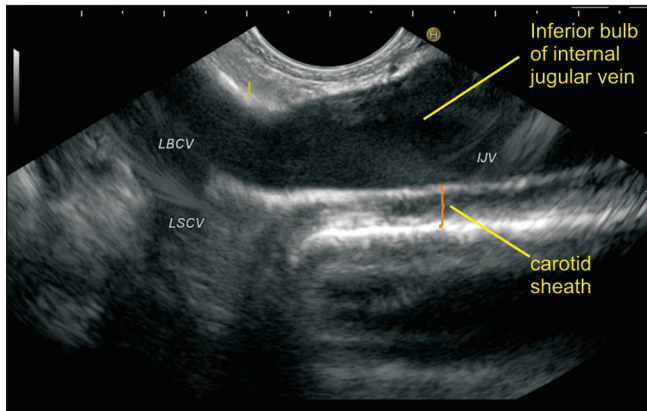
**Figure 9:** The thyroid gland is seen in the visceral space. The internal jugular vein is seen in the carotid sheath beyond the thyroid gland



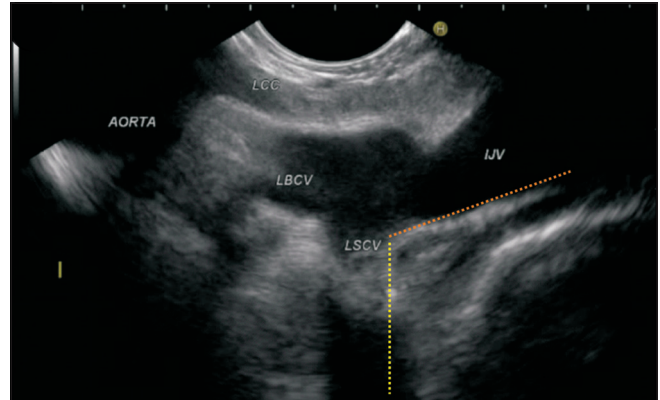
**Figure 10:** Anterior (central) compartment group VI lymph nodes include the pre- and paratracheal nodes, the precricoid (Delphian) node, and the perithyroidal nodes. A transverse section of ultrasound from the neck shows the thyroid gland and a lymph node lateral to thyroid gland between the LCC and LIJV. LCC = Left common carotid, LIJV = Left internal jugular vein

esophagus. The retropharyngeal space extends to the level of C6 in the upper neck and the retroesophageal space extends to the lower neck and the posterior mediastinum up to the level of T2 vertebra [Figure 14]

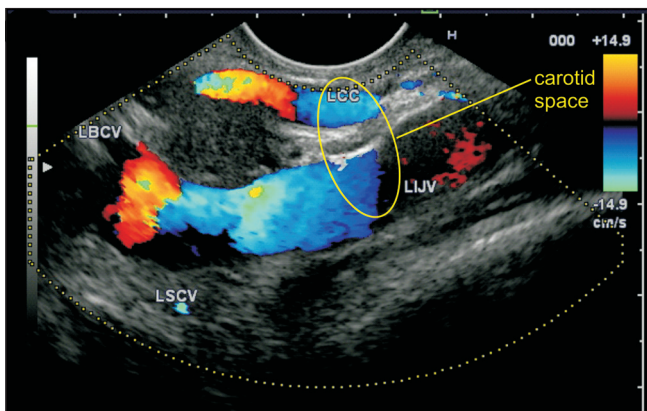
6. The danger space is a potential median space between



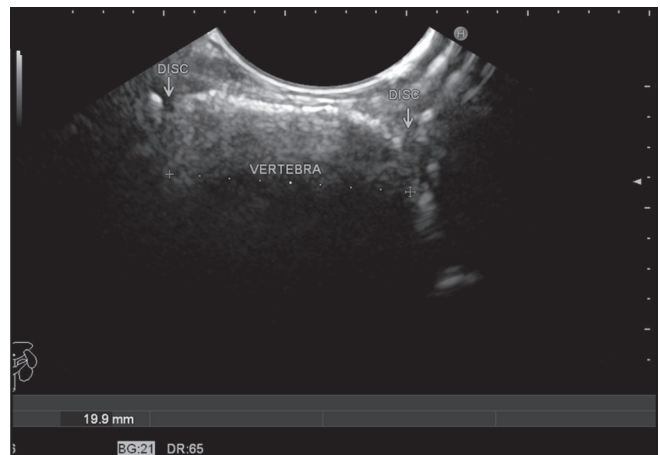
**Figure 11:** The carotid sheath is made of contributions from pretracheal, precervical, and superficial fascia. The union of the two veins is seen in the base of the neck, and the dilated lower part of the internal jugular vein is called the inferior bulb



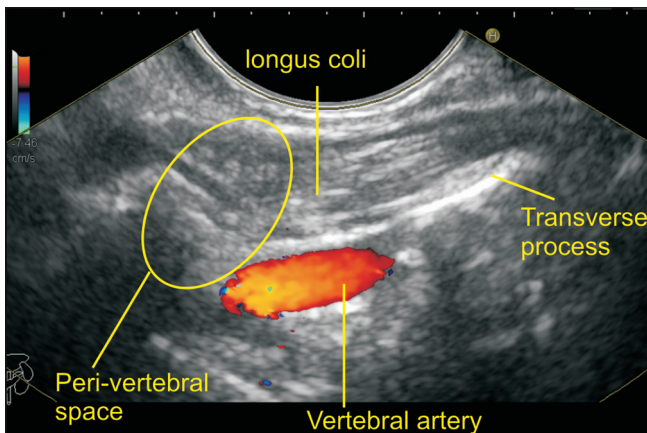
**Figure 12:** A union of the left subclavian vein and the left internal jugular vein is seen. This union lies in the cervical part of the mediastinum anterior to the cupola. The left subclavian vein arches upward and reaches almost to the lower boundary of the supraclavicular triangle. The area above the subclavian vein can be considered the supraclavicular triangle, whereas the internal jugular vein enters the carotid sheath within the carotid triangle



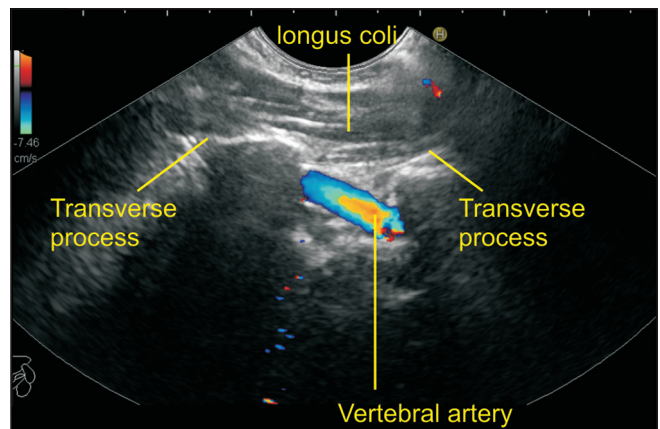
**Figure 13:** The carotid sheath in the neck includes the internal jugular vein and the common carotid artery. In this case, lymph nodes are seen within the carotid sheath



**Figure 14:** The alternating pattern of hyperechoic spine and hypoechoic intervertebral disc can be traced all the way to the base of the skull by a pullout along the posterior wall of the esophagus and pharynx



**Figure 15:** The vertebral artery is seen in the areas between the two adjacent transverse processes of vertebrae. The longus colli muscle is seen between the probe and the vertebral artery

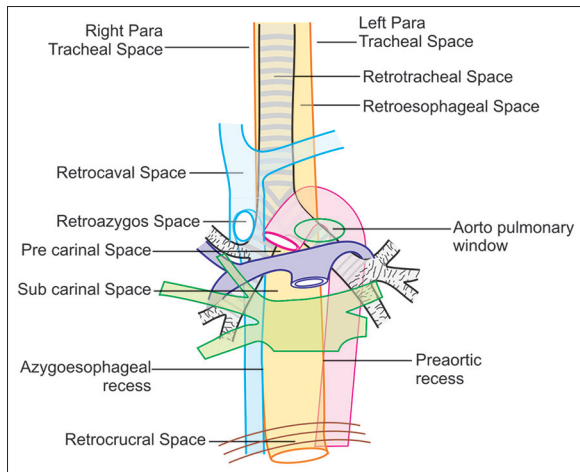


**Figure 16:** The longus colli muscle is seen in the paravertebral area. The transverse processes interrupt the visualization of the entire course of the artery

7. The perivertebral space is encased by the prevertebral layer of deep cervical fascia and is subdivided into a median prevertebral space in front of the vertebrae and paraspinous spaces on either side of the vertebrae [Figures 15 and 16] [Table 1].

**Applied anatomy of spaces of mediastinum**

The esophagus is divided into the cervical and thoracic portions. The cervical esophagus ends at the thoracic inlet. The rest of the esophagus is divided into three regions.<sup>[12]</sup> The upper thoracic portion extends from the thoracic inlet to the carina, the midthoracic portion extends from the carina to esophageal hiatus of the diaphragm, and the lower esophagus includes the intraabdominal esophagus

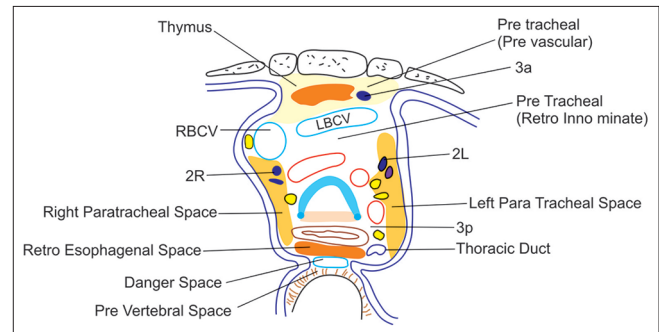


**Figure 17:** A coronal view of spaces around trachea and esophagus is seen. The trachea and esophagus divide the central zone of the mediastinum into left-sided and right-sided compartments. The tracheal bifurcation and the main bronchi divide the central zone into supracarinal and subcarinal areas. The spaces in the supracarinal area include the paratracheal spaces (on the right and left sides of the upper trachea), the pretracheal space, the AP window, and the retrotracheal space. The spaces in the subcarinal areas include the precarinal and the subcarinal spaces in continuity with the azygoesophageal and preaortic recesses

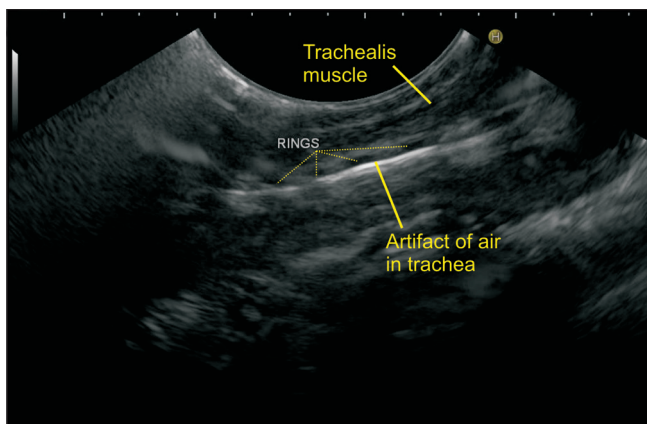
and the gastroesophageal junction.<sup>[11]</sup> The heart and major vessels divide the mediastinum into central and anterior zones.<sup>[19]</sup> CT images obtained after pneumomediastinography have also demonstrated several compartments of the mediastinum where spread of gas occurs from one space to another [Figure 17].<sup>[3,20]</sup> Different methods of imaging of the posterior mediastinum have been described and standard techniques of imaging of the different lymph node stations have been described by the International Association for the Study of Lung Cancer (IASLC).<sup>[21-25]</sup> The mediastinal spaces are described in this article as having boundaries, but in reality they are all continuous with each other directly or indirectly [Tables 2 and 3].

**Spaces anterior to trachea**

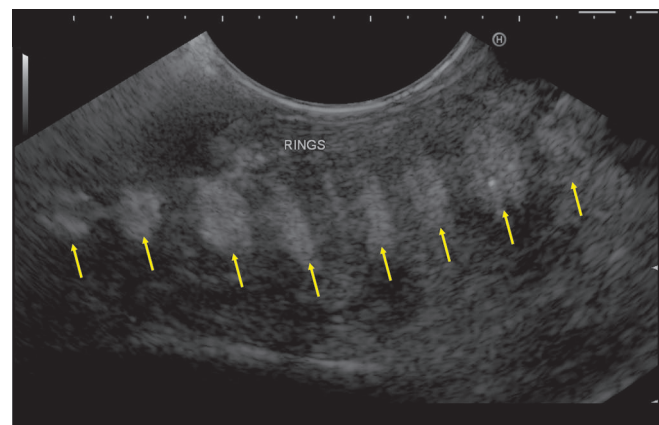
1. The pretracheal space lies in front of trachea and has been subdivided into the retroinnominate and retrocaval spaces [Figures 18–20].<sup>[26]</sup> The pretracheal spaces are generally retrovascular in location.
2. Prevascular space (anterior junctional area) represents the junction areas where the two lungs approximate each other and by the apposition of the visceral and parietal pleura of the lungs with intervening mediastinal fat.<sup>[25]</sup> The anterior junctional area lies anteromedial to the aorta and pulmonary artery and is also known as the prevascular space. The anterior



**Figure 18:** A cross-sectional view of spaces around the trachea



**Figure 19:** It is difficult to see the pretracheal space because of air in the trachea, which lies in front of the esophagus, and the presence of air in the trachea creates reverberation artifacts. The sound waves are transmitted through the trachealis muscle, which lies in the posterior wall of the trachea

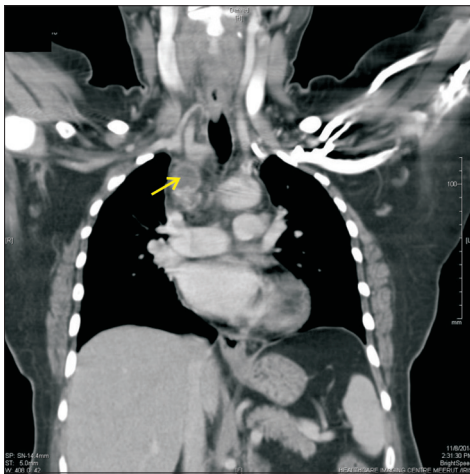


**Figure 20:** On a clockwise rotation to either side the rings of the trachea can be more easily appreciated (yellow arrows). The pretracheal space lies in front of the trachea and may be difficult to visualize by EUS; a transcatheter ultrasound can give more information

**Table 1: Spaces in infrahyoid region of neck**

Space	Boundaries	Contents	Communication
Anterior cervical space	S: Hyoid bone I: Superior mediastinum A: Strap muscles and sternocleidomastoid P: Carotid space M: Visceral space	L.N: Level 2-4	S: Attachment of strap muscles to hyoid bone I: Superior mediastinum
Posterior cervical space	A: Deep cervical fascia and sternocleidomastoid, Carotid space P: Prevertebral fascia	Fat, L.N: Level-5	L: Apex of axilla through cervicoaxillary canal
Visceral space	S: Hyoid bone I: Superior mediastinum A: Fascia covering the strap muscles P: Alar fascia, retropharyngeal space Lateral: anterior cervical space, carotid space	Larynx Trachea (cervical part) Hypopharynx Esophagus (cervical part) Thyroid, Parathyroid gland L.N: Level-6	A: Pretracheal space P: Retropharyngeal/retroesophageal space L: Posterior Cervical space
Carotid space	S: Base of skull I: Aortic arch A: Anterior cervical space P: Posterior cervical and perivertebral spaces M: Visceral and retropharyngeal spaces	Common and internal carotid arteries. Internal jugular vein L.N: Level 2-4	I: Superior mediastinum
Retropharyngeal/retroesophageal space	S: Base of skull I: Upto C6 retropharyngeal upto T2 retroesophageal A: Pharynx and esophagus P: Danger space	No L.N below the level of hyoid bone	Superior mediastinum
Danger space	S: Base of skull I: Posterior mediastinum up to diaphragm. A: Alar fascia and P: Prevertebral fascia	Potential space Fat L.N are absent	Infections can spread bi-directionally from base of skull to the level of diaphragm
Perivertebral space	S: Base of skull I: Coccyx A: Pharynx, esophagus, Antero lateral: Carotid space Postero lateral: Anterior portion of Posterior cervical space	Vertebral muscles L.N are absent	I: Into mediastinum and upto coccyx

S: Superior, I: Inferior, L: Lateral, A: Anterior, P: Posterior, m: Medial, L.N.: Lymph node



**Figure 21:** A follow-up case of large retrosternal thyroid goiter who underwent excision developed fever and retrosternal chest pain radiating to the right shoulder. CT coronal scan revealed a small, hypodense peripherally enhancing collection of 32 × 33 mm<sup>2</sup> size in the right paratracheal region abutting the SVC

junction area cannot be seen by EUS. The thymus lies in this space.

**Spaces lateral to trachea**

1. The right paratracheal space is wider than the left and becomes gradually narrower as it goes down toward the tracheal bifurcation [Figures 21–26].



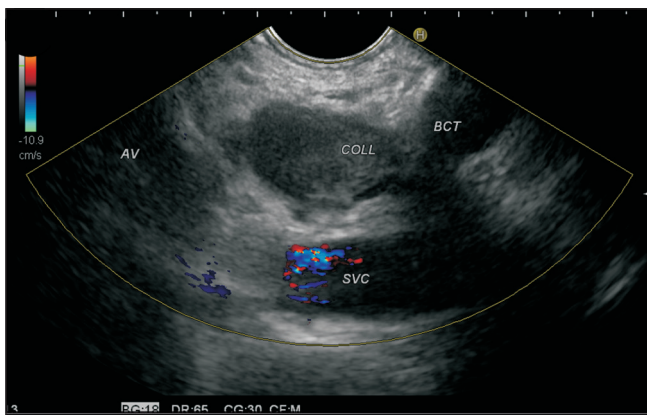
**Figure 22:** The transverse section of the same case as in Figure 21

2. The left paratracheal space lies to the left of the trachea and the esophagus. In a thin patient, the left paratracheal space is narrow and becomes broader as it goes down, particularly at the level of the aortopulmonary window [Figures 27–29].
3. The aortopulmonary window is specifically called a window (and not space), and it is created by the formation of an aortic arch over the left pulmonary artery in the left paratracheal region [Figures 30–34].

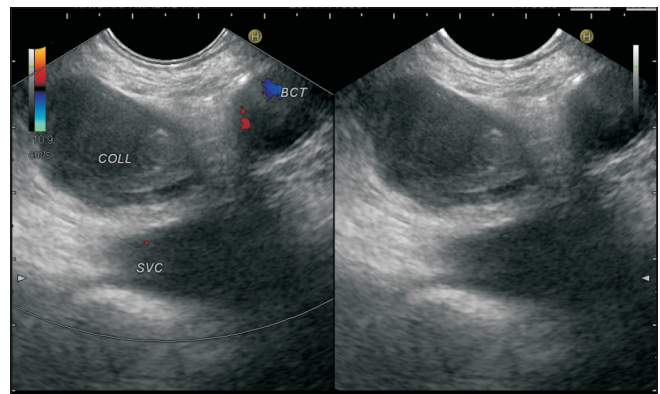
**Table 2: Spaces Anterior, lateral and posterior to trachea**

Space	Boundaries	Contents	Communication
Spaces anterior to trachea Prevascular space	S: Thoracic inlet I: Diaphragm A: Sternum, anterior ends of clavicle and ribs. P: Great vessels and Heart; (i) Upper level-RBCV, LBCV; (ii) Mid-level-anterior surface of SVC, Ascending aorta; (iii) Lower level-anterior surface of heart and pericardium	Thymus L.N: IASLC station 3a	S: Visceral space of neck. L: Paratracheal spaces
Pretracheal space-subdivided into (i) retroinnominate, (ii) retrocaval space	Lat: Mediastinal pleura at mid-level S: Thoracic inlet I: Carina P: Anterior surface of trachea, carina Right A: SVC and RBCV anteriorly. Left A: Ascending aorta and enveloping superior pericardial recess	L.N: IASLC station — 2R, 4R and 2L	S: Visceral space of neck. Right: Right paratracheal space Left: Left paratracheal space Aortopulmonary window, Subcarinal space
(i) Retro-innominate space	P: Anterior surface of trachea; A: RBCV and LBCV	Brachiocephalic trunk L.N:	S: Visceral space of neck. I: Retrocaval space
(ii) Retrocaval space	Right: Mediastinal pleura P: Anterior convexity of trachea A: Posterior surface of SVC and ascending aorta Left: Medial wall of aortic arch Right: Medial wall of arch of azygos vein	IASLC station —2R, 2L L.N: IASLC station 4R	L: Paratracheal spaces S: Retro-innominate space. Right: Right paratracheal space; Left: Aortopulmonary window
Spaces lateral to trachea Right paratracheal space	S: Thoracic inlet I: Right tracheobronchial angle M: Right aspect of trachea; L: Mediastinal pleura related to RBCV and SVC up to arch of azygos	L.N: IASLC station — 2R and 4R. Right Brachiocephalic vein enters this space.	Pretracheal space
Left paratracheal space	P: Vertebrae S: Thoracic inlet I: Left tracheobronchial angle, intrapericardial part of left pulmonary artery M: Trachea, esophagus	L.N: IASLC station — 2L	Pretracheal space and aortopulmonary window
Aorto-pulmonary window	L: Mediastinal pleura from inlet to aortic arch level A: Ascending aorta P: Descending aorta M: Left main bronchus L: Mediastinal pleura covering upper lobe of left lung; S: Concavity of arch of aorta I: Left pulmonary artery	Ligamentum arteriosum; L.N: IASLC Station — 4L, 5 and 6	Right and left paratracheal spaces and subcarinal space
Spaces posterior to trachea Retro-tracheal space (raider's triangle)	S: Thoracic inlet I: Aortic arch A: Posterior aspect of trachea P: Vertebra	Esophagus Thoracic duct L.N: IASLC station — 3p	S-posterior part of visceral space of neck, I-subcarinal space Azygoesophageal recess
Retrocaval space (at aortic hiatus)	A: Crura of diaphragm and median arcuate ligament P: T-12 vertebra	Descending Aorta, Thoracic duct, Azygos vein Hemiazygos vein L.N: IASLC station 8	Communicates posterior mediastinum with retroperitoneum of upper abdomen

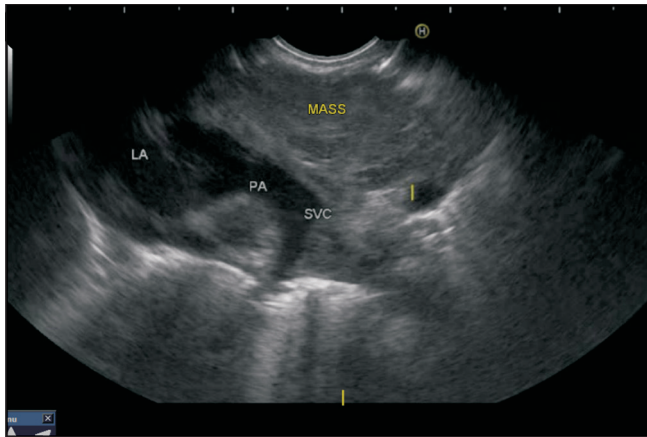
RBCV: Right Brachiocephalic vein, LBCV: Left Brachiocephalic vein, SVC: Superior vena cava, IASLC: International Association of Study of Lung Cancer



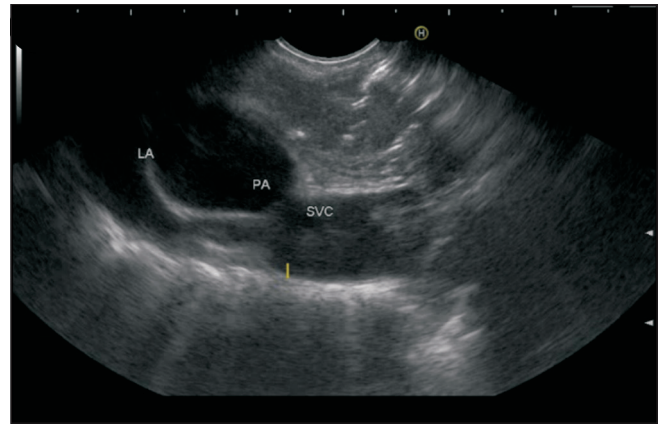
**Figure 23:** EUS was able to show the same collection in right paratracheal space. The collection lies between the esophagus and SVC and can be also called as retrocaval in location



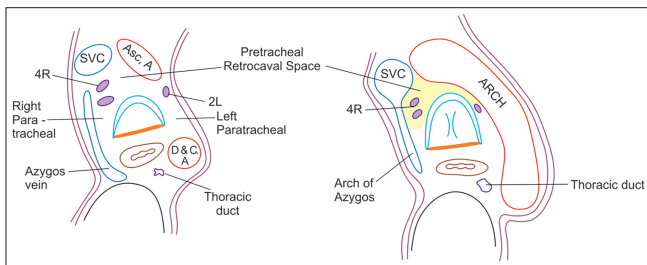
**Figure 24:** The right paratracheal area is generally considered to be a difficult area for imaging by EUS, but in this case it was easily visualized by EUS. The brachiocephalic trunk is also seen



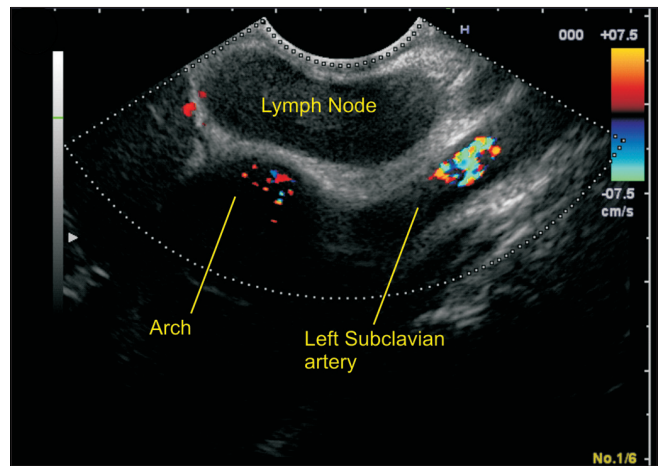
**Figure 25:** The right paratracheal space is a continuation of pretracheal space. It is generally bigger and wider



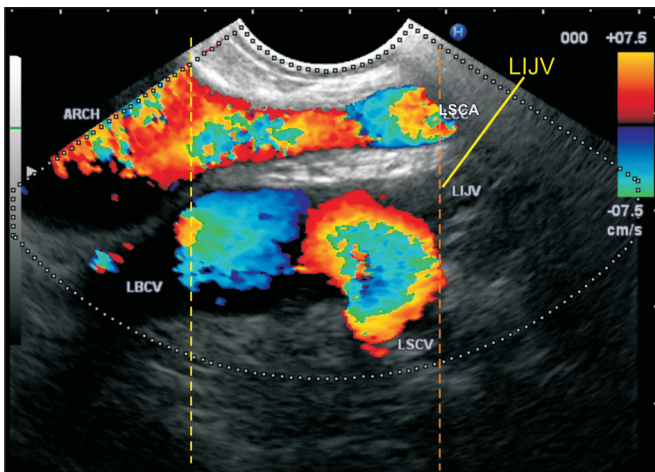
**Figure 26:** In this case, the union of the azygos vein with SVC is seen and a mass is seen between the azygos vein and the union of SVC



**Figure 27:** This figure shows the continuity of spaces around the trachea with each other



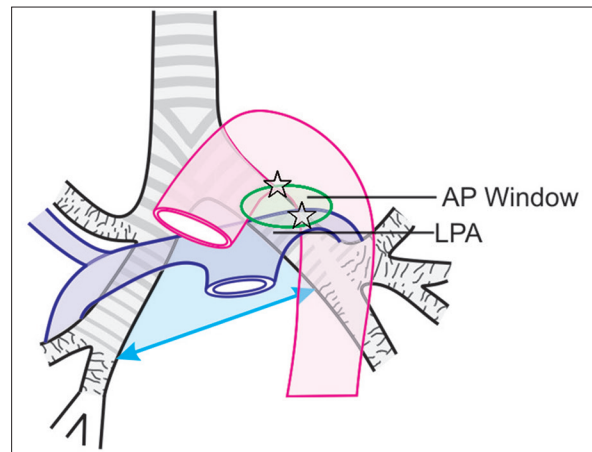
**Figure 28:** The examination of the arch of the aorta shows the origin of the left subclavian artery and a lymph node belonging to a metastatic station of head and neck malignancy



**Figure 29:** The EUS image shows the origin of the left subclavian artery from the arch of the aorta. The formation of the left brachiocephalic vein is observed by the union of the left internal jugular vein and the left subclavian vein near the lower part of the supraclavicular triangle. In general, the venous system is larger and lies more laterally, and is observed beyond the left common carotid artery in this image. The yellow line represents the upper border of the aortic arch and the orange line shows the lowermost point of the supraclavicular triangle. LBCV = left brachiocephalic vein; LCC = left common carotid artery; LIJV = left internal jugular vein; LSCV = left subclavian vein

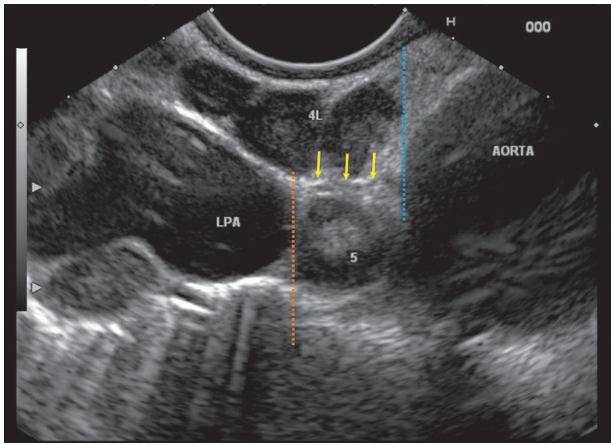
**Spaces posterior to trachea**

Most of the spaces behind the trachea are continuations of the neck spaces and have been already described.

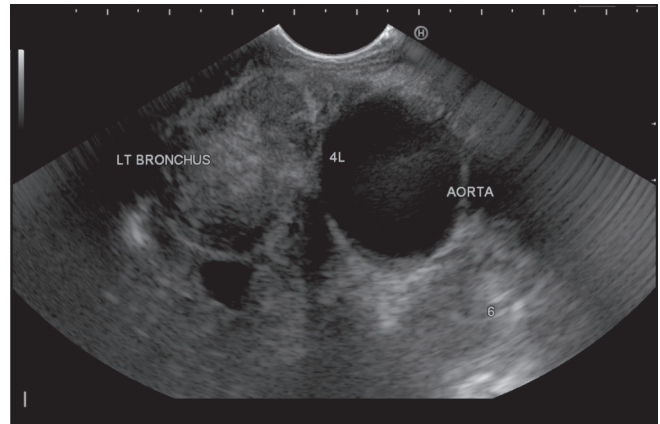


**Figure 30:** The aortopulmonary (AP) window lies immediately below the arch of the aorta above the left pulmonary artery (oval green circle). It is bounded superiorly by the inferior margin of the aortic arch; inferiorly by the superior margin of the left pulmonary artery; anteriorly by the posterior wall of the ascending aorta; posteriorly by the anterior wall of the descending aorta; medially by the trachea and the left main bronchus, and esophagus; and laterally by the left lung and left upper-lobe pleurae. The AP window merges with the subcarinal space

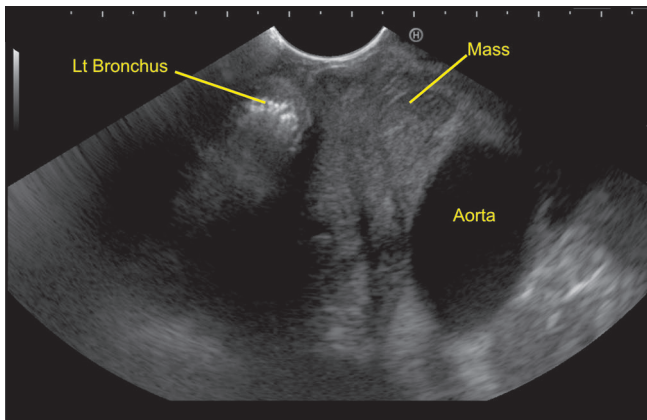




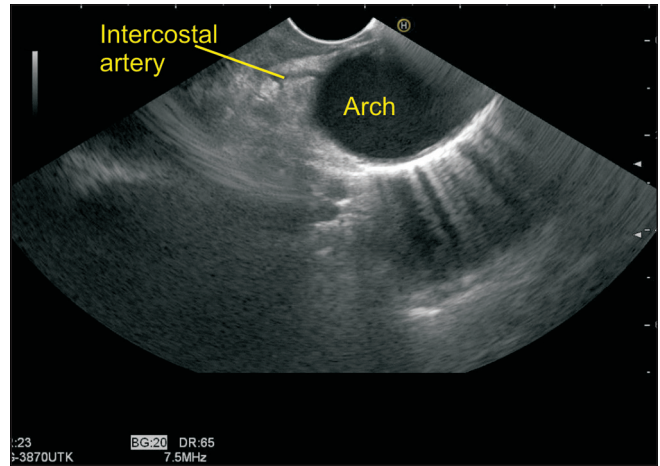
**Figure 31:** The AP window is bounded superiorly by the inferior margin of the aortic arch (dotted blue line) and inferiorly by the superior margin of the left pulmonary artery (dotted orange line); the ligamentum arteriosum is seen in an imaginary line between the arch of the aorta and the left pulmonary artery. In this case the ligamentum arteriosum is indicated by yellow arrows. The lymph node medial to ligamentum arteriosum is labelled as station 4L and the lymph node lateral to the ligament is labelled as station 5



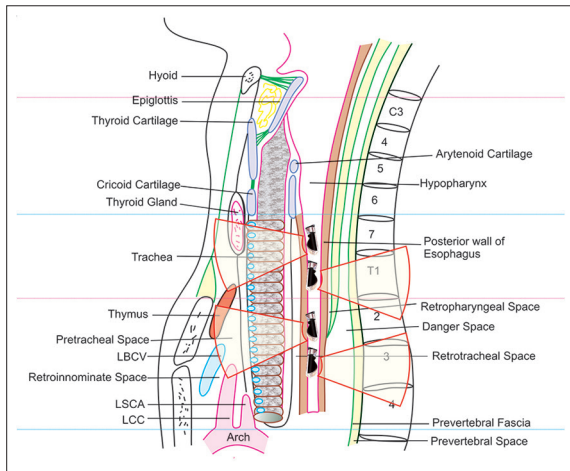
**Figure 32:** A mass is seen in the AP window



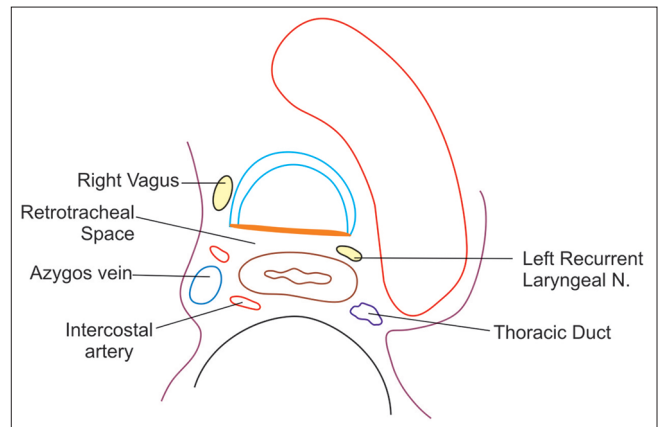
**Figure 33:** The same case as Figure 32. The left bronchus is seen just below the mass, can be traced going toward the left hilum of the lung on anticlockwise rotation, and shows the extension of mass up to the lower limit of the AP window



**Figure 34:** The contents of the aortopulmonary window include the bronchial arteries; in this case a bronchial artery is seen going from the lower aspect of the aortic arch into the aortopulmonary window. Label in figure

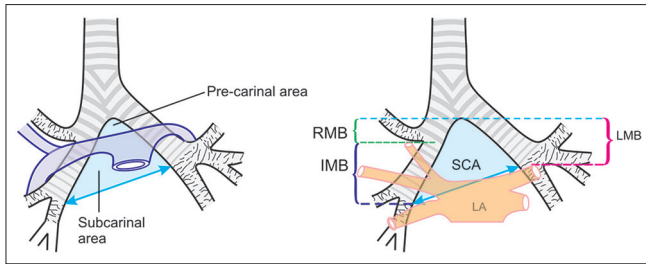


**Figure 35:** The figure shows a coronal section of different spaces and the technique of EUS imaging. The retrotracheal space is seen

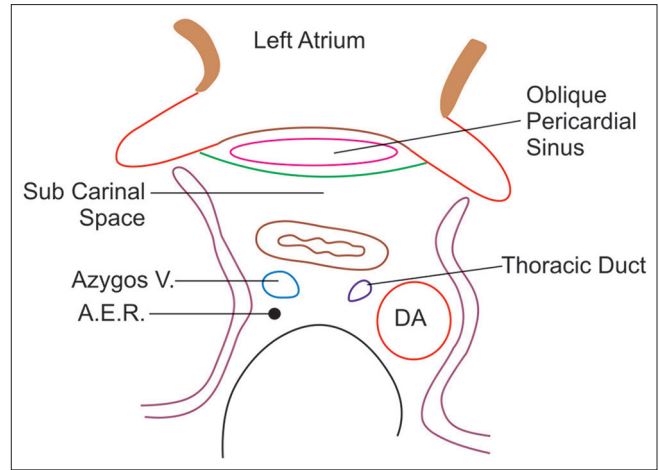


**Figure 36:** The area of arches shows the position of different spaces at T4 vertebral level

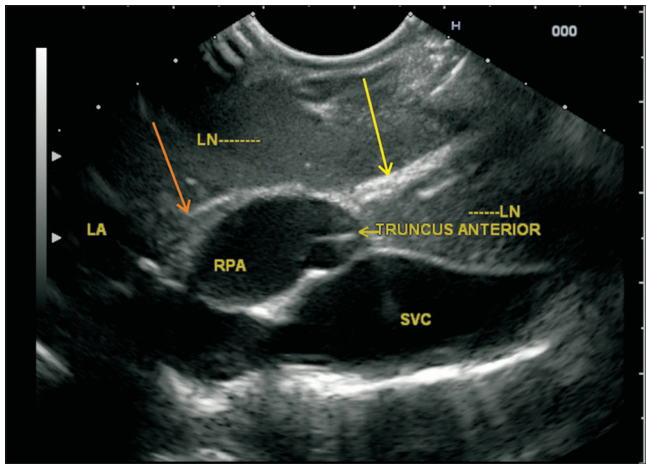
1. The retrotracheal space (or Raider triangle) lies between the esophagus and the trachea and is normally triangular in shape [Figures 35 and 36].<sup>[27]</sup>
2. The posterior junctional area lies posterior to the trachea and esophagus, is formed by the apposition of



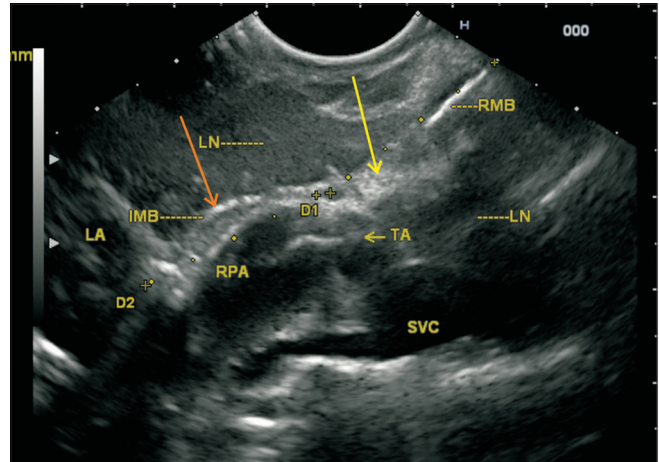
**Figure 37:** IASLC classification defines subcarinal window/area (light blue triangular area) as a pyramidal space, the tip of which lies at the tracheal bifurcation. The right boundary (~5 cm) is formed by the right bronchus (~2.5 cm) and intermediate bronchus (~2.5 cm), and the left boundary is formed by left main bronchus (~5 cm). The lower limit of the SCA is formed by an oblique line drawn from the lower border of the intermediate bronchus to the lower border of the left atrium (~3–4 cm in breadth). RMB = Right main bronchus, LMB = Left main bronchus, IMB = Intermediate bronchus, SCA = Subcarinal area shown in blue triangle. RMB = Right main bronchus, LMB = Left main bronchus, IMB = Intermediate bronchus



**Figure 38:** This figure shows the relationship of the subcarinal space with the oblique sinus of the pericardium, and the pathway of communication with the azygoesophageal and preaortic recesses



**Figure 39:** The right boundary of the subcarinal space can be defined with ease if the right pulmonary artery is followed up to its bifurcation. In this image, the division of the right pulmonary artery and the right bronchus defines the right boundary of the subcarinal space



**Figure 40:** The right pulmonary artery divides into two branches near the right main bronchus (yellow arrow) and intermediate bronchus (orange arrow). The upper branch of the right pulmonary artery goes to the right upper lobe and is called truncus anterior. On the right, the truncus anterior courses inferior to the right upper lobe bronchus at the hilum and then passes anterosuperior to the bronchus as it exits the hilum. The upper border of this division corresponds to the lower border of the right main bronchus and the lower limit of the paratracheal space on the right side. Yellow arrow = Right main bronchus, RMB = Right main bronchus, Orange arrow = Intermediate bronchus, IMB = Intermediate bronchus, RPA = Right pulmonary artery, SVC = Superior vena cava, LA = Left atrium

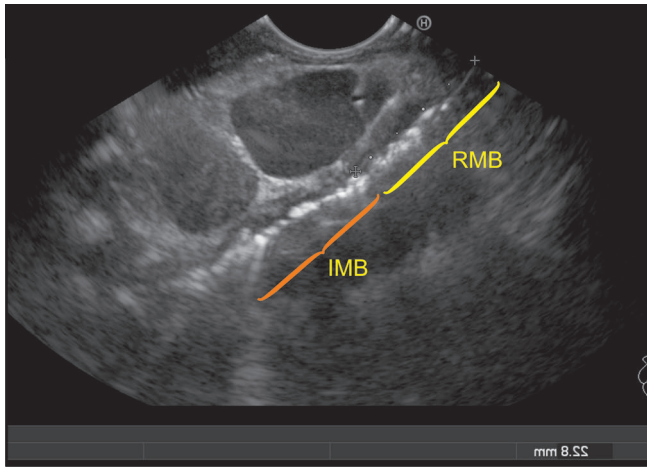
the lungs posterior to the esophagus, and lies anterior to the vertebral bodies of T3 to T5 vertebrae.<sup>[28-32]</sup> The posterior junction line can be seen above the level of the azygos vein and the aorta by EUS.

**Spaces below trachea**

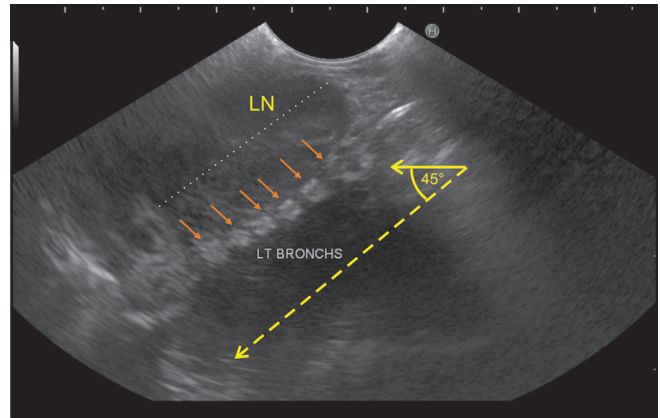
This space is ideally called the subcarinal compartment but is sometimes described as two intercommunicating spaces that are partly separated by the right pulmonary artery. One is called the precarinal space and the other is called the subcarinal space. The subcarinal compartment is continuous below with the azygoesophageal and preaortic recesses.

1. The precarinal space merges imperceptibly with the aortopulmonary window on the left and continues below into the subcarinal area [Figure 37]

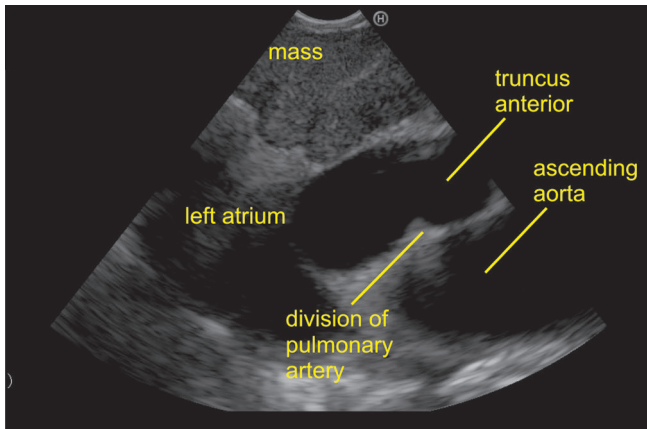
2. The subcarinal space is sometimes described as the area below the carina and sometimes as the area below the right pulmonary artery. It commonly contains benign triangular lymph nodes [Figures 38-43]
3. The azygoesophageal recess (also called “Holzknecht space” or “retroesophageal recess/pouch”) is the interface between the right lower lobe of the lung and the mediastinal reflection inferior to the arch of the azygos vein [Figures 44 and 45]



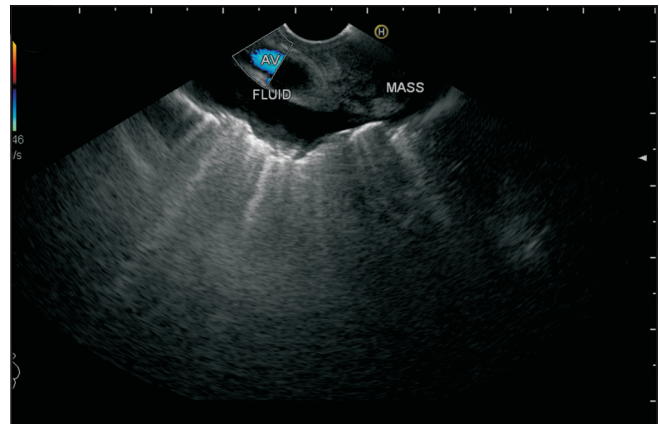
**Figure 41:** The right boundary of the subcarinal area is approximately 5 cm in length and is formed by right main bronchus, which is about 2.5 cm in length, and intermediate bronchus, which is about 2.5 cm in length. Air is seen within the right main bronchus and the intermediate bronchus. In this case, two lymph nodes are seen and one of them lies close to the right main bronchus, whereas the other lies close to the intermediate bronchus. (yellow arrow indicates RMB = Right main bronchus, orange arrow indicates IMB = Intermediate bronchus)



**Figure 42:** The right bronchus takes an angle of about 45° from midline as it proceeds toward the hilum of the left lung (dotted yellow arrow). It is seen in the subcarinal window anterior to the esophagus and can be traced from the lower margin of the trachea with clockwise rotation. As the scope is rotated clockwise, the left bronchus proceeds in an angle of about 45° from midline and in this case is seen as multiple interrupted rings (small orange arrows). The subcarinal space is the entire space between the probe and the left bronchus



**Figure 43:** The imaging of subcarinal area can be done at ~ 27 cm distance in the esophagus. The lower boundary of station 7 is made by the left atrium. In this case, the right pulmonary artery is seen dividing into two branches. The division of the right pulmonary artery into two branches occurs after crossing the bronchus. The upper branch is known as truncus anterior



**Figure 44:** The esophagus contacts the upper lobe of both lungs, and only the pleural sacs intervene between the esophagus and lung. The pleural sacs may be filled with fluid, which can come up posteriorly below the azygos vein, which arches above the right bronchus to join the SVC. In this case, there is a tumor involving the arch of the azygos vein and pleural effusion close to the azygos vein. The esophagus goes through the superior mediastinum and remains in contact with both upper lobe of lungs, whereas the trachea gets separated from the lung on the left side by the branches of the aorta

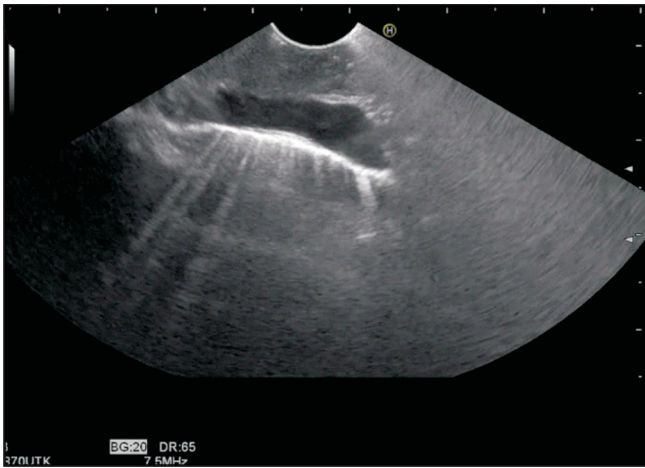
4. The preaortic recess is an inconstant space analogous to the azygoesophageal recess and is present in individuals whose left lung is able to extend anterior to the descending aorta [Figure 46]
5. The retrocrural space lies between the diaphragmatic crura and the T12 vertebra.<sup>[18]</sup>

### Spaces related to pericardium

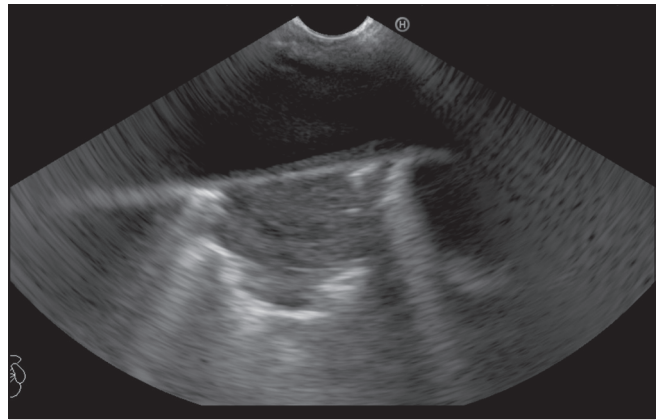
The pericardium surrounds the heart and extends cranially to cover the pulmonary trunk, superior vena cava (SVC), and ascending aorta. On EUS the normal amount of 15–20 mL of pericardial fluid can produce well-circumscribed contours with a variety

of shapes including triangular, crescent-shaped, oval, or beaklike extensions.<sup>[33]</sup> The pericardial cavity contains the pericardial cavity proper and two major pericardial sinuses, the transverse and oblique sinuses [Figures 47 and 48].<sup>[34]</sup>

1. The transverse sinus is located cephalad to the left atrium. It gives origin to the superior and inferior aortic recesses and the left and right pulmonary recesses [Figure 49]<sup>[35-38]</sup>
2. The oblique sinus is the most posterior pericardial space. Fluid in the oblique sinus can simulate abnormalities in the esophagus, descending thoracic



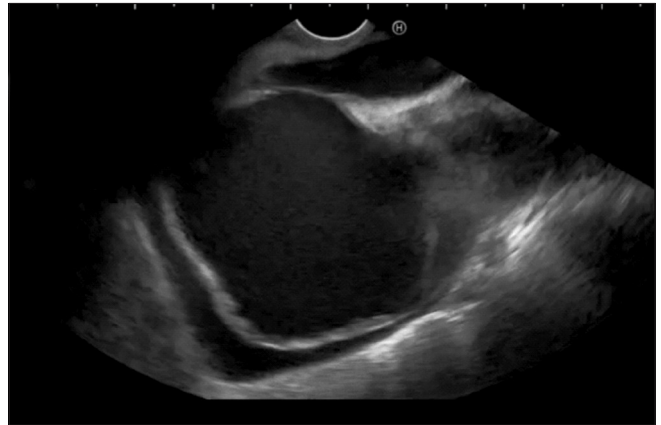
**Figure 45:** The azygos vein runs close to esophagus, and in this case the esophageal tumor is extending into the azygoesophageal recess. The reflection of the sound waves from the right lung is seen as a white line along the distal border of the azygos vein



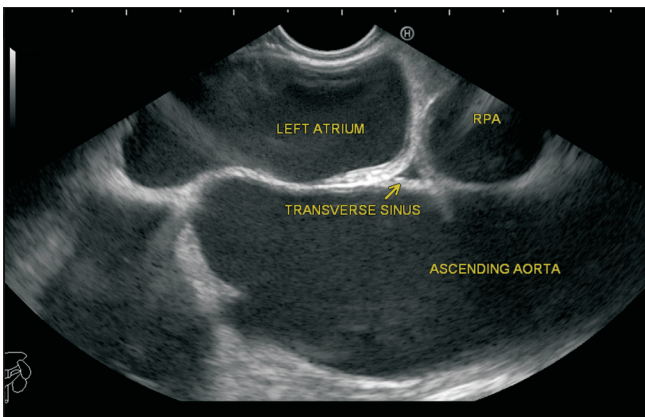
**Figure 46:** The aorto-esophageal recess generally lies in the area between the esophagus and the adjacent aorta. In this case, a mass is seen beyond the aorta and lies within the close-to-posterior basal segment of the left lung



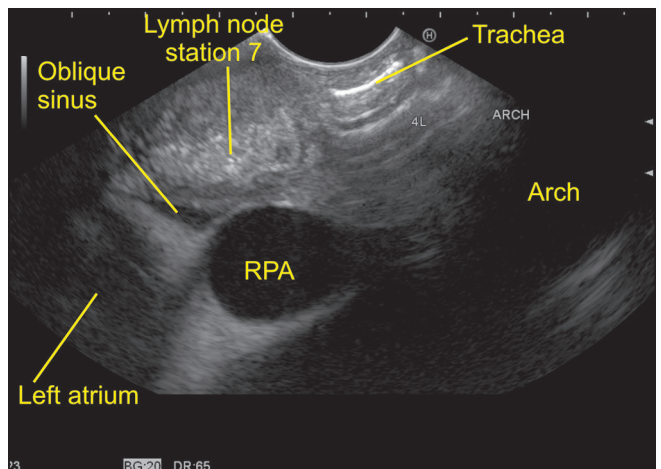
**Figure 47:** The superior aortic recess is an extension of transverse sinus, which extends upward along the right side of the ascending aorta usually to the level of the sternal angle, and can mimic adenopathy at the right and left paratracheal stations



**Figure 48:** A small amount of fluid is seen in the tip of the pericardial cavity



**Figure 49:** A larger amount of fluid is seen in the pericardial cavity, as indicated by yellow arrows



**Figure 50:** The oblique sinus of the pericardium is seen between the right pulmonary artery and the left atrium

aorta, and subcarinal and bronchopulmonary lymph nodes [Figure 50].

**Table 3: Spaces below trachea**

Pre-carinal	S: Pre-tracheal space I: Sub-carinal space, Left pulmonary artery on the left and truncus anterior of right pulmonary artery on the right Left: Left pulmonary artery A: Ascending aorta P: Carina	L.N: IASLC station — 7, sometimes station 10R	I : Subcarinal space
Subcarinal space*	S: Tracheal bifurcation and main bronchi I: Top of left atrium A: Intrapericardial part of pulmonary arteries and veins and Posterior wall of heart; P: Esophagus Right: Azygos vein and posterior mediastinal pleura Left : Descending aorta and posterior mediastinal pleura	L.N: IASLC station — 7	S: Aortopulmonary window and retro-tracheal spaces I: Azygo-esophageal recess on the right side
Azygo-esophageal recess (space of Holzkecht)	S: Subcarinal space I: Right hemidiaphragm Anteromedial: Esophagus, Azygos vein, Left atrium P: Vertebral column	Fat Azygos vein L.N: IASLC station — 8	S: Subcarinal space I: Retrocrural space
Preaortic recess (inconstant space)	S: Sub carinal space I: Diaphragm, may end higher up also as aorta courses towards mid-line. A: Esophagus and left lung P: Vertebrae and descending aorta	L.N: IASLC station —8	S: Subcarinal space I: Retrocrural space

\*Subcarinal space and Subcarinal compartments are often confused with each other. Subcarinal compartment includes subcarinal and precarinal space

## CONCLUSION

The trachea and the esophagus pass through the center of the mediastinum and are responsible for the formation of many spaces. These spaces are continuous with the potential space in the neck. The description of the spaces in the neck generally coincides with the presence of lymph node stations as described for head and neck cancers. The description of the spaces in the mediastinum generally coincides with lymph node stations as described in IASLC classification. Knowledge of the spaces is important to head, neck, and thoracic surgeons because these anatomic areas are used daily for radiographic interpretation as well as for the performance of surgical procedures.<sup>[28]</sup> The evolution of CT technology has improved detection of these spaces, and more detailed imaging is now routinely pursued before planning management strategies. Knowledge of the typical locations and of typical and atypical appearances on EUS can prevent misdiagnosis and help in appropriate management.

**Financial support and sponsorship**  
Nil.

## Conflicts of interest

There are no conflicts of interest.

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