Pictorial Essay

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Findings of Endoscopic US and CT of Esophageal Disease

식도 질환의 내시경 초음파 및 전산화단층촬영 소견

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Various diseases can affect the esophagus. Endoscopic ultrasound (EUS), which provides precise information about the layers of the esophageal wall, is the primary approach used to investigate esophageal diseases. However, CT is one of the most important imaging modalities for diagnosing esophageal diseases as it can elucidate mediastinal involvement, adjacent lymphadenopathy, and distant disease spread. These two modalities complement each other in the diagnosis of esophageal diseases. Although radiologists may be unfamiliar with EUS procedures and their interpretation, understanding them aids in the differential diagnosis of esophageal conditions. This pictorial essay illustrates the EUS and CT findings of various esophageal diseases originating in the esophageal wall.

Index terms Esophagus, Diseases; Esophagus, Neoplasms; Esophagus, US; Esophagus CT; Ultrasound, Endoscopic

INTRODUCTION

CT is a widely used to diagnose thoracic diseases. However, CT alone has limited ability to differentiate some esophageal diseases because it may provide little information about the intestinal wall layers, which is important in the differential diagnosis of diseases originating in the esophageal wall. However, due to the proximity of the endoscopic ultrasound (EUS) transducer to the organs of interest, EUS images can provide more accurate and detailed information about the intestinal wall layers (1). However, EUS has limited ability to assess mediastinal involvement, adjacent lymphadenopathy, and distant spread of the disease, which are more accurately detected on CT.

These two diagnostic modalities complement each other in the diagnosis of esophageal disease. Although radiologists may be unfamiliar with EUS procedures and their interpretation, understanding them can help in the differential diagnosis of esophageal diseases.

In this study, we described the EUS and CT findings of various esophageal diseases based on the layer of the esophageal wall from which they originate.

NORMAL ESOPHAGEAL ANATOMY

The esophagus is a muscular tube measuring 20–24 cm in length, composed of outer longitudinal and inner circular muscle fibers lined by stratified squamous epithelium. Histologically, the esophageal wall consists of five layers: superficial mucosa (epithelium), deep mucosa (lamina propria and muscularis mucosa), submucosa, muscularis propria (composed of an inner circular and outer longitudinal layer), and adventitia (Fig. 1). On EUS, the esophageal wall typically appears as a five-layered structure. However, a high-frequency probe (20–30 MHz) can detect up to nine layers (Fig. 2, Table 1) (2). The layers of the esophageal wall cannot be distinguished on CT and their thickness varies on CT according to the degree of distention; a thickness of ≥5 mm is considered abnormal (3).

EUS AND CT FINDINGS OF ESOPHAGEAL PATHOLOGY

Classification by the layer of origin in the esophageal wall was the most useful means of categorizing esophageal lesions using EUS (Table 2).

SUPERFICIAL MUCOSAL LAYER LESIONS

IDIOPATHIC EOSINOPHILIC ESOPHAGITIS

Idiopathic eosinophilic esophagitis (IEE) is a chronic inflammatory disease characterized

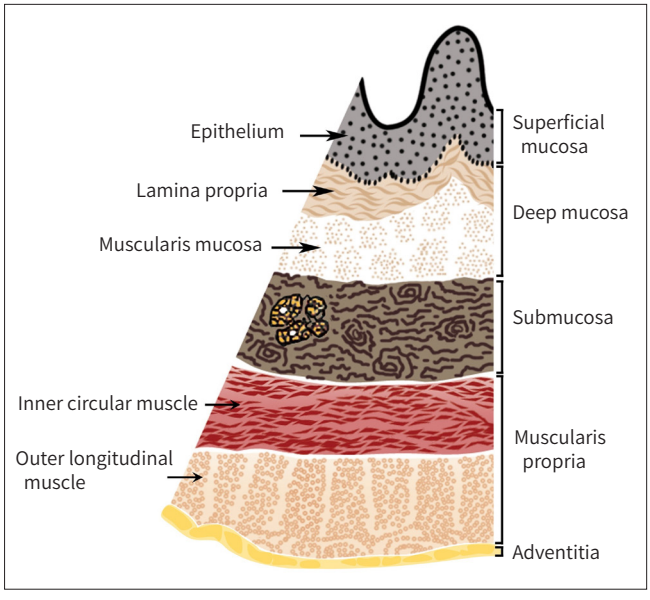


Fig. 1. Schematic illustration of the five layers of the normal esophageal wall revealed by histology: the superficial mucosa (epithelium), the deep mucosa (lamina propria and muscularis mucosa), submucosa, muscularis propria (composed of an inner circular and outer longitudinal layer), and adventitia.

Fig. 2. Endosonographic image and schematic illustration of the normal esophageal wall determined using a high-resolution probe. The normal esophageal wall typically appears as a nine-layered echo structure (red box) under a high-resolution endoscopic ultrasonography.

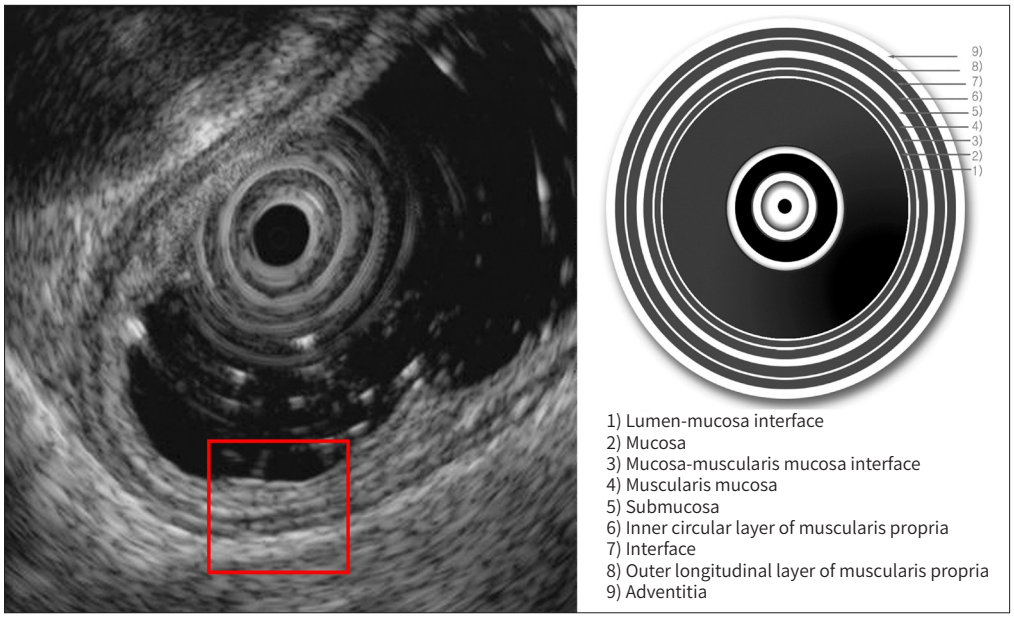


Table 1. Nine-Layered Structures of the Normal Esophageal Wall as Depicted by Endoscopic Ultrasound

Layer	Histology	Echogenecity
1st	Interface lumen-mucosa	Hyperechoic
2nd	Mucosa	Hypoechoic
3rd	Interface mucosa-muscularis mucosa	Hyperechoic
4th	Muscularis mucosa	Hypoechoic
5th	Submucosa	Hyperechoic
6th	Inner circular layer of muscularis propria	Hypoechoic
7th	Interface inner circular-outer longitudinal layer of muscularis propria	Hyperechoic
8th	Outer longitudinal layer of muscularis propria	Hypoechoic
9th	Adventitia	Hyperechoic

by eosinophilic infiltration of all layers of the esophagus, most commonly the mucosal layer (4). IEE is generally attributed to the inflammatory reactions triggered by ingested food allergens (4). IEE affects children and occasionally adults, particularly young males (aged 20–40 years), with persistent dysphagia (4). Most patients with IEE have esophageal strictures in the proximal or mid-esophagus, often with ring-like indentations that result in a ringed appearance on esophagography (4). The CT finding of the IEE was non-specific esophageal submucosal edema (Fig. 3A) (5). The most common endoscopic findings were concentric mucosal rings (81%) and linear furrows (74%) (Fig. 3B) (6). IEE was observed as a circumferential but asymmetric thickening of the mucosa or muscularis propria on EUS (Fig. 3C) (7).

PAPILLOMA

Esophageal squamous papilloma (ESP) is a rare benign esophageal tumor that is usually as-

Table 2. Endoscopic Ultrasound Classification of Esophageal Lesions by Layer of Origin in the Esophageal Wall

Endoscopic Ultrasound Layer	Esophageal Lesions
Superficial mucosa	Idiopathic eosinophilic esophagitis*
	Papilloma
	Esophageal cancer
Deep mucosa	Granular cell tumor†
Submucosa	Fibrovascular polyp
	Lipoma
	Hemangioma
	Varix
	Metastasis‡
Muscularis propria	Schwannoma§
	Idiopathic muscular hypertrophy
	Leiomyoma‖
	GIST
	Duplication cyst¶

*Idiopathic eosinophilic esophagitis is characterized by eosinophilic infiltration in all layers of the esophageal wall, most commonly in the mucosa.
†Granular cell tumors extend from the lamina propria to the submucosa.
‡Metastasis involving the deep mucosa, submucosa, and muscularis propria.
§Schwannoma originates at the submucosa or muscularis propria.
‖Leiomyomas and GISTs may theoretically arise from the deep mucosa; however, these tumors usually arise from the muscularis propria.
¶Duplication cysts arise in the submucosa or muscularis propria of esophageal wall.
GIST = gastrointestinal stromal tumor

ymptomatic without characteristic symptoms (8). ESPs are typically encountered as incidental small solitary polyps in the esophagus (average size, 6 mm) (8, 9). Radiological reports of esophageal papillomas are rare. Kao et al. (10) reported that multiple sessile lesions were associated with incomplete esophageal stenosis and irregular luminal contours, suggesting esophageal papillomatosis.

On endoscopy, ESPs generally appear as single round, elevated, sessile, whitish, or pinkish-colored lesions with a soft consistency (Fig. 4A) (8). EUS reveals that ESPs are confined to the mucosa without muscularis propria invasion (Fig. 4B) (11).

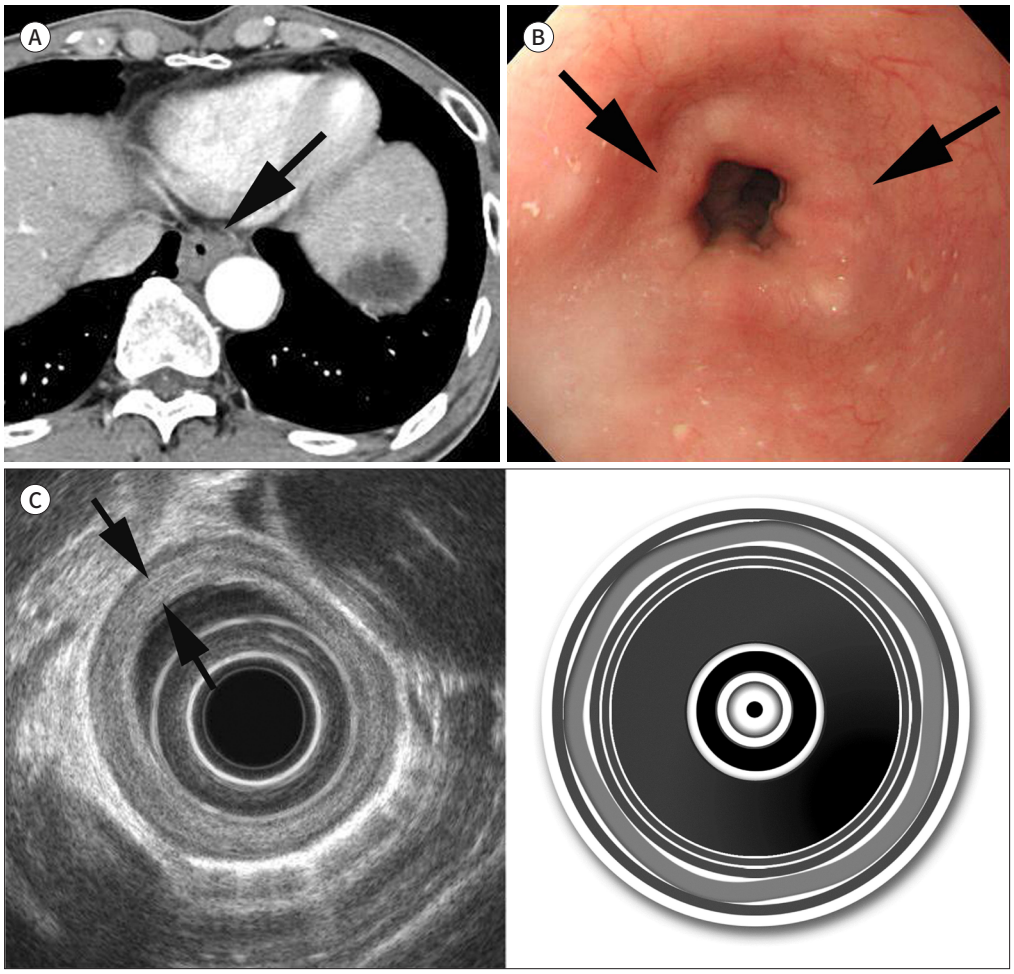
ESOPHAGEAL CANCER

Esophageal cancer is the eleventh most common cancer and the seventh leading cause of cancer-related deaths worldwide (12). The incidences of the two main subtypes (squamous cell carcinoma and adenocarcinoma) vary regional variation (13). Globally, squamous cell carcinoma accounts for approximately 85% of all esophageal cancer cases; however, adenocarcinoma is more common in many parts of North America and Europe. The first and most common symptom is difficulty swallowing, followed by weight loss, chest pain, nausea, and vomiting.

Based on the recommendations in the Worldwide Esophageal Cancer Collaboration report, the 8th edition of the American Joint Committee on Cancer and Union for International Cancer Control TNM staging guidelines was introduced (14).

Many methods can be used for esophageal cancer staging, including CT, ^{18}F-fluorodeoxy-

Fig. 3. Eosinophilic esophagitis in a 77-year-old male.
A. An axial contrast-enhanced CT scan obtained at the level of the hepatic dome shows circumferential wall thickening (arrow) of the lower esophagus.
B. Endoscopic image shows a concentric mucosal ring (arrows).
C. Endoscopic ultrasonography image and schematic show circumferential wall thickening of the inner circular muscle layer with hyperechoic changes (arrows).



glucose PET/CT, and EUS. In this study, we briefly mention the T categorization. The esophageal wall layers could not be differentiated using CT imaging (15) (Fig. 5A). Thus, esophageal cancer T categories cannot be accurately diagnosed using CT. The most important role of CT in T categorization is the identification of fat plane loss between the tumor and adjacent organs that may invade the possibility of invasion of adjacent organs (16). Other signs of potential direct invasion include >90° of contact between the tumor and aorta, displacement or indentation of adjacent structures, and pericardial thickening or effusion. The endoscopic findings of esophageal cancer vary according to the type and depth of invasion. EUS was the modality of choice for assessing the penetration depth of the primary tumor through the esophageal wall (Fig. 5B). The diagnostic accuracy of EUS in early esophageal cancer, particularly when differentiating mucosal (T1a) and submucosal (T1b) lesions, is controversial and varies greatly between studies. The lowest and highest sensitivities and specificities of EUS in early esophageal cancer have been reported to be 72% and 48% and 85% and 87%, respec-

Fig. 4. Esophageal squamous papilloma in a 49-year-old male.
A. Endoscopic image shows a pinkish submucosal tumor (arrow) with a slightly rough surface.
B. Endoscopic ultrasonography image and schematic show a well-defined hyperechoic mass (arrows) that arose in the superficial mucosal layer.

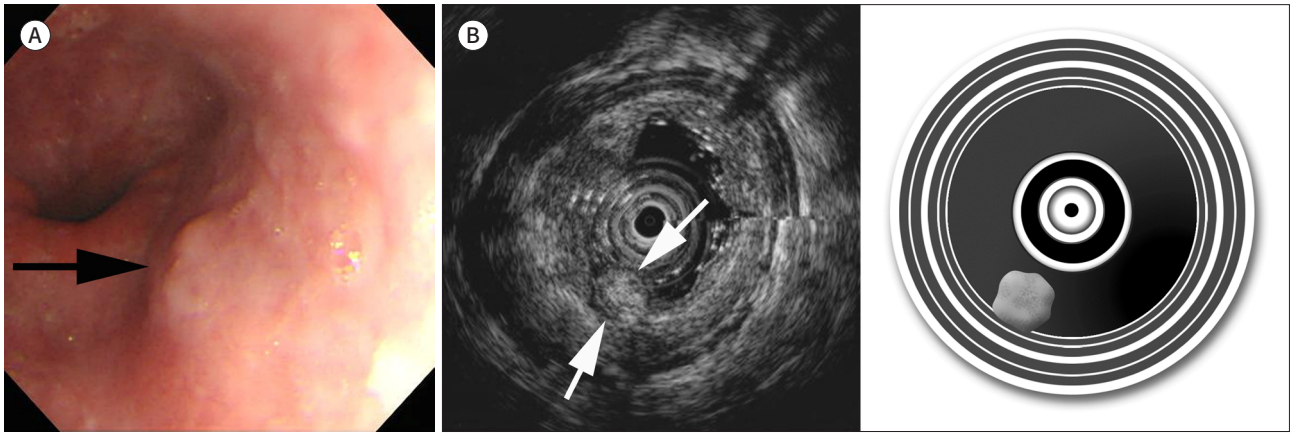
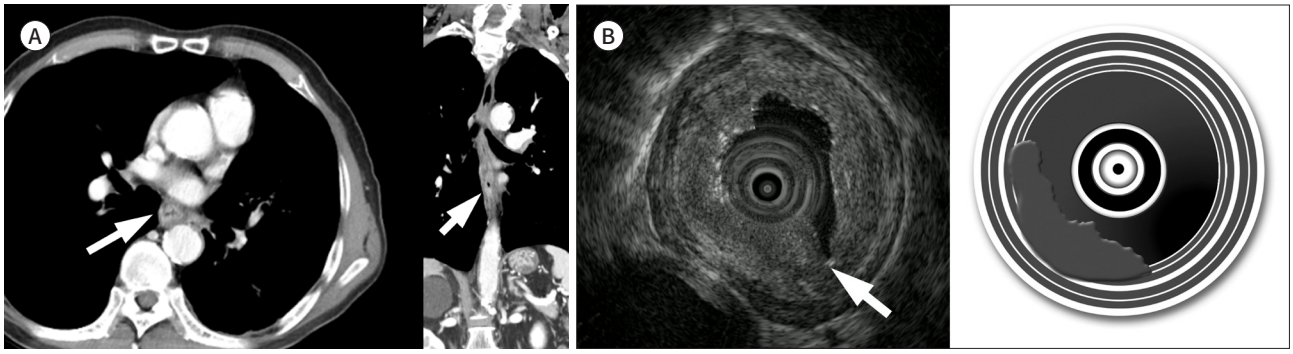


Fig. 5. T1b esophageal cancer in a 70-year-old male.
A. Axial and coronal contrast-enhanced CT images demonstrate irregular wall thickening (arrows) of the mid to lower esophagus without adjacent mediastinal lymphadenopathy. Note the preservation of fat plane between the esophagus and adjacent mediastinal structures.
B. Endoscopic ultrasonography image and schematic show a heterogeneous isoechoic mass (arrow) confined to the mucosal and submucosal layers.



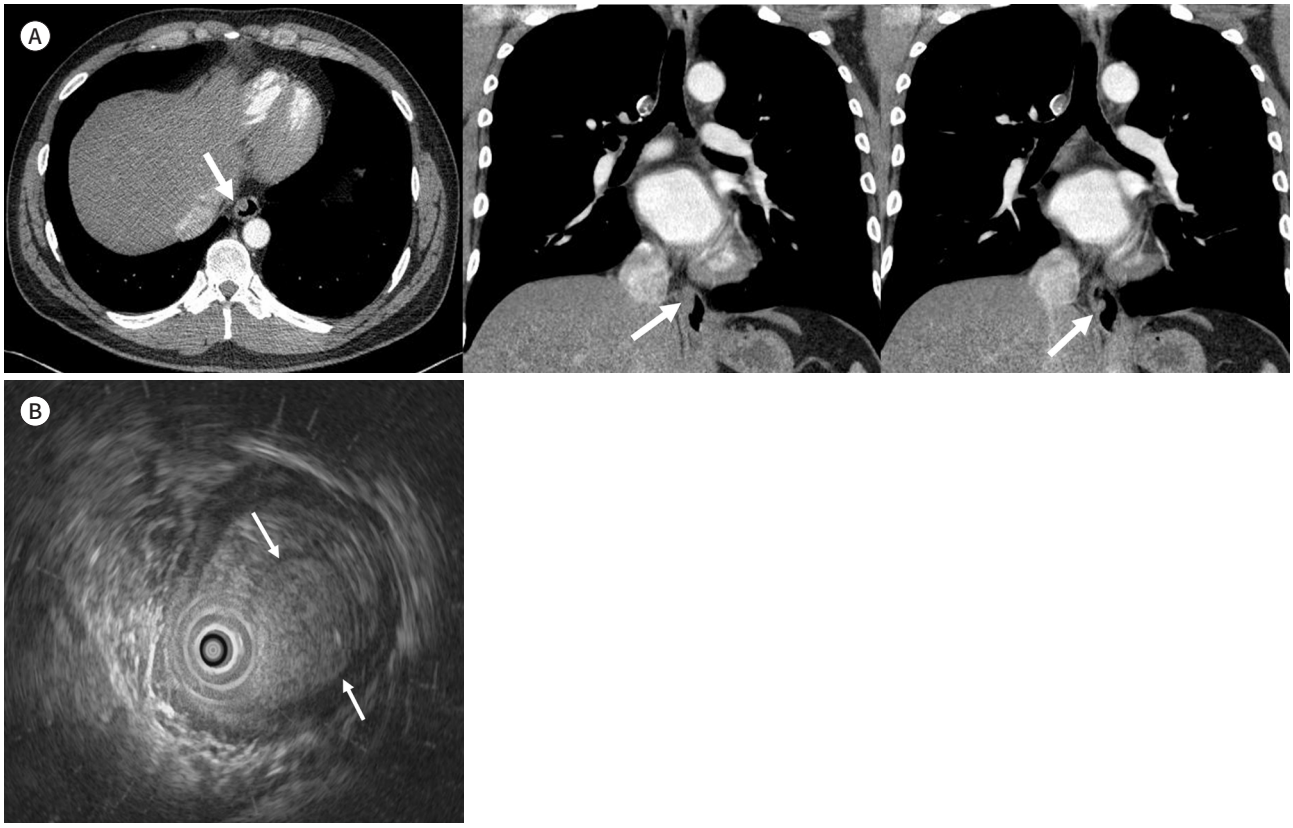
tively (14). Differentiation between T1a and T1b lesions is critical because lymph node metastases are associated with submucosal invasion, necessitating esophagectomy (14).

DEEP MUCOSAL LAYER LESIONS

GRANULAR CELL TUMOR

Granular cell tumors (GCTs) are rare lesions that usually occur as solitary lesions in the distal esophagus (17). GCTs are often asymptomatic but may cause dysphagia or substernal pain if they are >1 cm in size (17). CT demonstrated a well-defined mass circumferentially involving the esophagus (Fig. 6A). Endoscopically, GCTs appeared as grayish-white to yellow nodules or plaques with diameters <10 mm (18). EUS findings of GCTs are usually smooth hypoechoic solid masses extending from the lamina propria to the submucosal layer, with features similar to those of leiomyomas (Fig. 6B) (19). However, the echogenicity of GCTs is slightly higher than that of leiomyomas (20).

Fig. 6. Granular cell tumor in a 42-year-old male.
A. Axial and coronal contrast-enhanced CT images show a small-sized polypoid nodule (arrows) in the distal esophagus.
B. Endoscopic ultrasonography image shows isoechoic or slightly hypoechoic mass (arrows) with smooth margin in the submucosal layer.



SUBMUCOSAL LAYER LESIONS

FIBROVASCULAR POLYP

Fibrovascular polyps are rare benign mesenchymal tumors that manifest as pedunculated intraluminal masses that grow to a large size in the esophagus (21, 22). Histologically, these lesions are composed of loose or dense fibrous tissue, adipose tissue, and vascular structures covered by a normal epithelium (21). Fibrovascular polyps almost always arise in the upper third of the esophagus near the cricopharyngeus (21). The most common complaints were dysphagia, vomiting, weight loss, and respiratory issues (21).

The attenuation values of fibrovascular polyps depend on the proportions of fibrous and adipose tissue as determined using CT (23). Endoscopy is usually used for the diagnosis, although polyps covered with normal soft mucosa can be overlooked (Fig. 7A).

On EUS, the fibrovascular polyps exhibited increased echogenicity, presumably because of their high fat content (Fig. 7B). If a fat-containing mass originating from the submucosal layer is observed in the upper esophagus, a fibrovascular polyp should be considered as a potential differential diagnosis.

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Fig. 7. Fibrovascular polyp in a 49-year-old male.
A. Endoscopic image shows the presence of a huge submucosal tumor (arrowheads) with a smooth surface that occupied the entire esophageal lumen.
B. Endoscopic ultrasonography image and schematic show a heterogeneous hyperechoic mass (arrows) that arose in the deep mucosal layer.

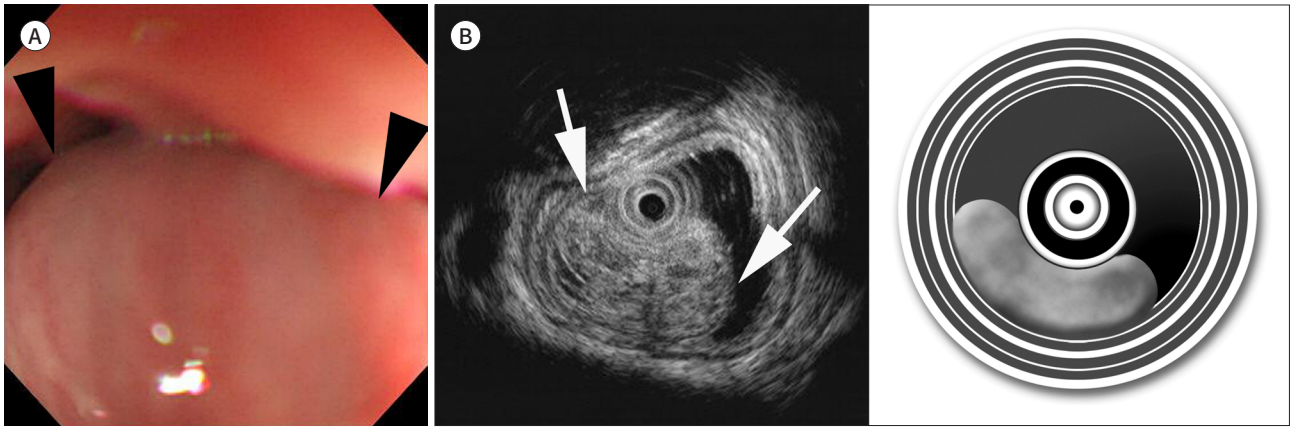
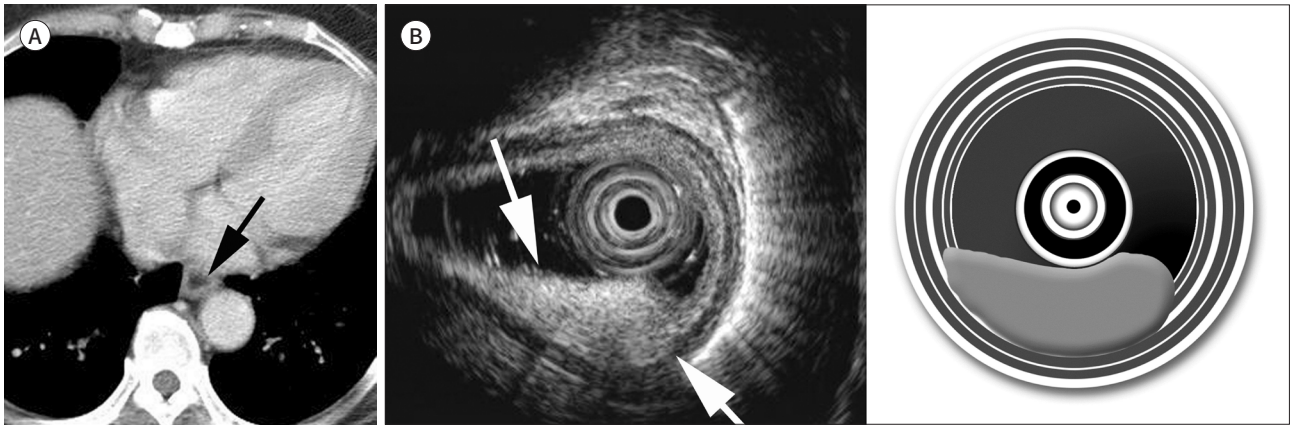


Fig. 8. Esophageal lipoma in a 65- year-old female.
A. An axial contrast-enhanced CT image obtained at the level of the hepatic dome shows a well-defined mass (arrow) with fatty density in the distal esophagus.
B. Endoscopic ultrasonography image and schematic show a well-defined hyperechoic mass (arrows) that arose in the third layer (submucosa) of the esophageal wall.



LIPOMA

Esophageal lipomas are rare, accounting for only 0.4% of benign tumors of the gastrointestinal (GI) tract tumors. Most lipomas are small, do not cause symptoms, and are found incidentally during imaging studies (24). Lipomas are visualized as well-defined, low-attenuating masses on CT images; yellow, pliable, smooth-surfaced lesions on endoscopy (Fig. 8A); and hyperechoic masses with a smooth, well-defined border that arises from the submucosa on EUS (Fig. 8B) (19, 20).

HEMANGIOMA

Esophageal hemangiomas are rare benign esophageal tumors with only 23 clinical cases reported in the literature (25). CT images show well-defined soft tissue masses with small cal-

cifications or phleboliths in the esophageal wall (26). Contrast-enhanced CT images revealed that esophageal hemangiomas are homogeneously enhanced due to considerable vascularity (Fig. 9A) (26). Endoscopically, hemangiomas are usually described as submucosal, bluish, compressible, protruding lesions that appear anywhere along the esophagus (25). On EUS, hemangiomas range from anechoic to hypoechoic to isoechoic and involve the mucosal and submucosal layers with an intact muscularis propria (Fig. 9B) (19).

VARIX

Esophageal varices are usually found in patients with portal hypertension because of dilatation of the mucosal plexus of the GI wall.

Characteristic CT findings of esophageal varices include thickening of the esophageal wall, presence of a slightly lobulated outer contour, scalloped esophageal lumen with protruding luminal masses, and enhancement of the esophageal wall resembling that of the aorta (Fig. 10A) (27).

Endoscopy has become the gold standard method for evaluating esophageal varices, and their appearance depends on the grade and degree of air insufflation. On EUS, varices appear as hypoechoic, serpentine, and tubular lesions located in the submucosa with or without perigastroesophageal collateral veins (Fig. 10B) (28).

METASTASIS

Autopsy studies suggest that the overall incidence of metastasis to the esophagus in patients succumbing to cancer is approximately 3%–6%; the breast and lungs are the most common primary tumor sites (29). Secondary esophageal involvement from other primary malignancies occurs by direct extension from nearby organs or metastasis to the esophagus via the lymphatic system or bloodstream (29). These spread mechanisms result in a submucosal location with normal overlying mucosa, making endoscopic diagnosis difficult. CT re-

Fig. 9. Esophageal hemangioma in a 42-year-old male.
A. An axial contrast-enhanced CT image (portal venous phase) obtained at the level of the hepatic dome shows a small enhancing submucosal lesion (arrow) in the distal esophagus.
B. Serial endoscopic ultrasonography images show a hyperechoic mass that arose in the submucosal layer. The hypoechoic central portion (arrow) in left image changes into an isoechoic lesion (arrow) right image after a few seconds.

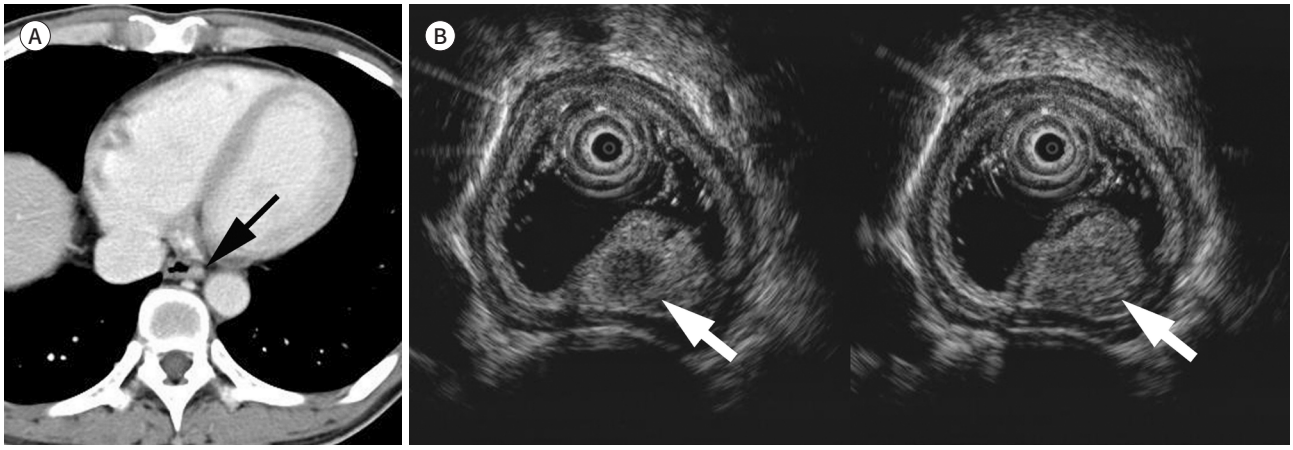


Fig. 10. Esophageal varices in a 68-year-old male with advanced liver cirrhosis.
A. An axial contrast-enhanced CT image (portal venous phase) shows enhancing tubular structures (esophageal varices) in and around (paraesophageal varices) the esophagus.
B. Endoscopic ultrasonography image of the esophagus and schematic show multiple, hypoechoic, serpentine, submucosal, tubular structures (arrows) representing varices.

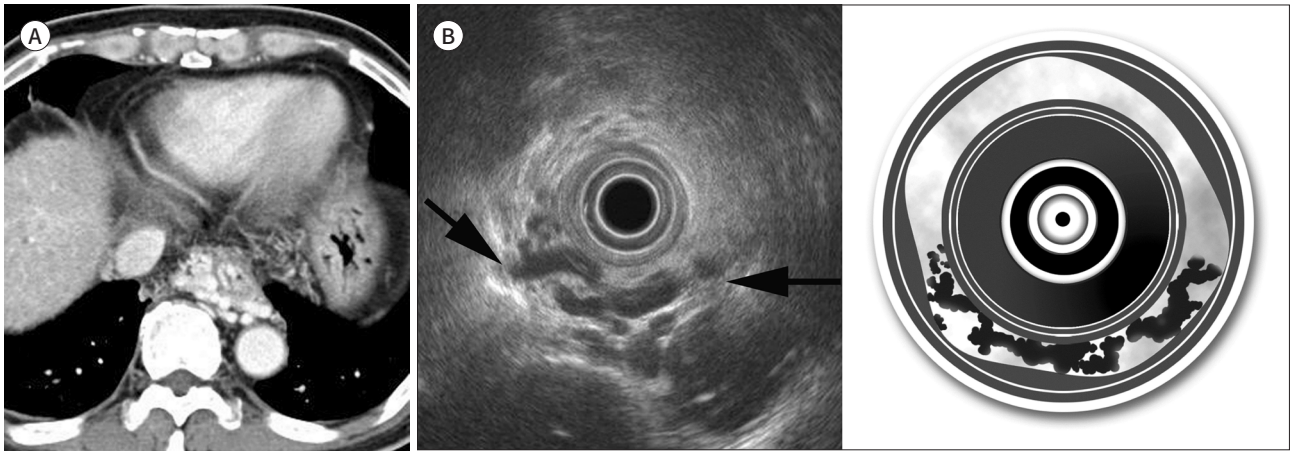
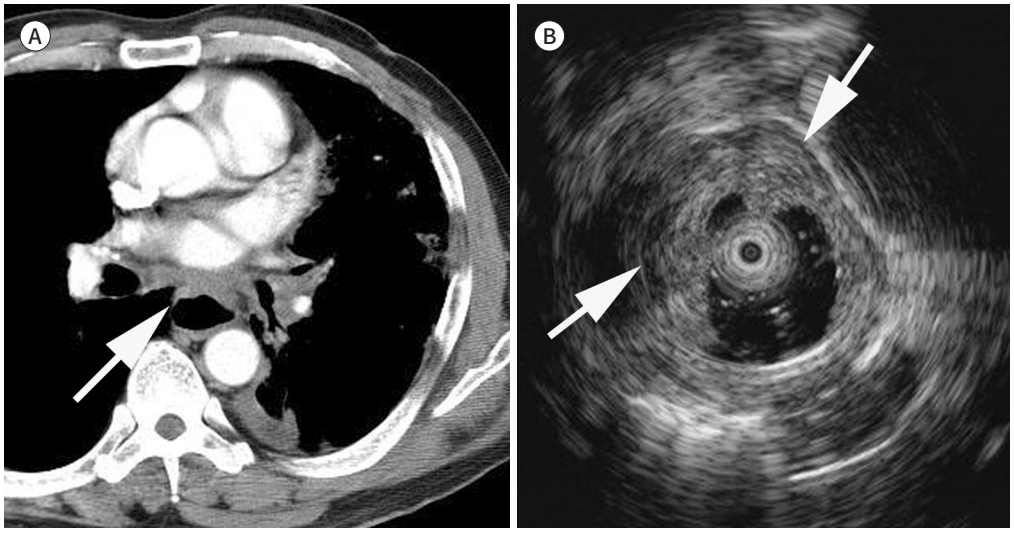


Fig. 11. Secondary esophageal carcinoma in a 56-year-old male with lung cancer.
A. Mediastinal window of an axial contrast-enhanced CT image demonstrates asymmetrical wall thickening (arrow) of the lower esophagus with adjacent mediastinal lymphadenopathy.
B. Endoscopic ultrasonography image primarily shows asymmetrical wall thickening (arrows) of the muscularis propria layer. Endoscopy revealed esophageal luminal narrowing with intact overlying mucosa (not shown).



vealed concentric thickening of the esophageal wall over a stricture with no associated extrinsic esophageal mass (Fig. 11A) (29). EUS revealed an asymmetrical wall thickening of the muscularis propria (Fig. 11B). The EUS findings of metastases are similar to those of leiomyomas but are distinguished by the higher and heterogeneous echogenicity of the mass. Additionally, metastases have irregular and ill-defined margin (20). EUS provides more accurate information concerning whether lesions are intrinsic or extrinsic to the esophageal wall, in addition to whether periesophageal masses or lymphadenopathy are present, and potentially

obtains biopsies under US guidance to confirm diagnosis using aspiration of submucosal lesions (29).

MUSCULARIS PROPRIA LAYER LESIONS

SCHWANNOMA

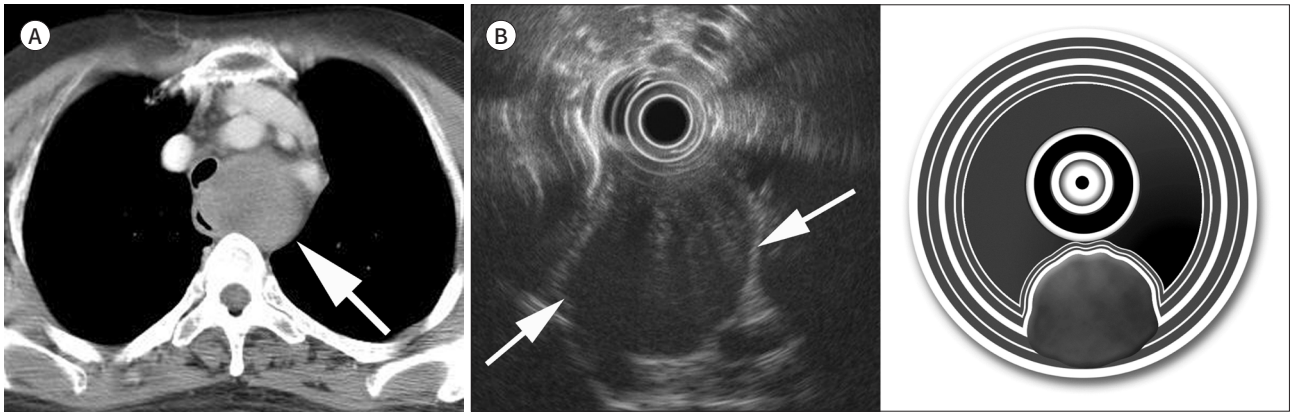
Neurogenic tumors are the most common primary mediastinal tumors, whereas benign esophageal schwannomas are rare (30). Benign schwannomas are usually located in the upper esophagus and occur in middle-aged females (3). Dysphagia was the most common symptom. Differentiating schwannomas from other submucosal tumors during preoperative examinations is challenging because of the lack of distinctive characteristics (3, 30).

The primary differential diagnoses for esophageal submucosal tumors include gastrointestinal stromal tumors (GISTs) and leiomyomas, which are the most common esophageal mesenchymal neoplasms (3). However, esophageal schwannomas present as homogeneously enhancing, well-defined masses on contrast-enhanced CT images, whereas other stromal tumors usually appear heterogeneous (Fig. 12A) (31). The EUS findings of the schwannoma were nonspecific (hypoechoic mass), except for its origin in the submucosa or muscularis propria (Fig. 12B) (31). There were no distinct features distinguishing it from other submucosal tumors. Therefore, a definitive diagnosis should be confirmed using histology (31).

IDIOPATHIC MUSCULAR HYPERTROPHY

Idiopathic muscular hypertrophy of the esophagus is characterized by the thickening of the esophageal wall at the lower esophagus, mainly due to hypertrophy of the circular muscle. This hypertrophy is usually confined to the circular smooth muscle layer, with rare involvement of the longitudinal layer and/or muscularis mucosa (32). Most of the patients were males in their sixth decade of life (32). Symptoms usually consist of retrosternal pain with dysphagia, vomiting of undigested food, and weight loss late in the course of the disease (32).

Fig. 12. Esophageal schwannoma in a 53-year-old female.
A. An axial contrast-enhanced CT image demonstrates a homogeneous, soft-tissue lesion (arrow) of 40 mm diameter that occupied the left posterior mediastinum.
B. Endoscopic ultrasonography image and schematic show a well-defined heterogeneous hypoechoic mass (arrows) that arose in the muscularis propria layer.



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Esophagoscopic findings are nonspecific and may reveal the presence of a normal esophagus (32). However, CT revealed circumferential thickening of the esophageal wall (Fig. 13A) (33). The normal thickness of the muscularis propria did not exceed 2 mm on EUS; however, idiopathic muscular hypertrophy appeared as circumferential thickening of the hypoechoic muscularis propria on EUS (Fig. 13B) (34).

LEIOMYOMA

Leiomyomas are the most common benign esophageal tumors, accounting for at least half of all benign esophageal tumors. Lesions may arise from the muscularis propria, submucosa, muscularis mucosa, or smooth muscles in the blood vessels of the esophageal wall. Approximately 60% of leiomyomas are located in the distal third of the esophagus and approximately 30% in the middle third (35). Approximately 50% of patients remain asymptomatic, whereas those who typically experience varying levels of dysphagia and substernal pain are primarily influenced by the tumor size and growth characteristics (35, 36).

On CT, leiomyomas are smooth-marginated, round, or ovoid masses of muscle attenuation lying intramurally or eccentrically within the esophageal wall (Fig. 14A) (36). Calcifications were reported in 11% of the leiomyomas (Fig. 14A) (36).

Endoscopically, these lesions appear as well-circumscribed round or oval masses with tense and intact overlying mucosa. On EUS, these lesions appeared as well-demarcated, smooth-marginated, hypoechoic lesions with fine, evenly scattered internal echoes that arose in the muscularis propria or the muscularis mucosa (Fig. 14B) (19). Occasionally, leiomyomas exhibit strong internal echoes owing to calcification (Fig. 14B).

GASTROINTESTINAL STROMAL TUMORS

GISTs are the most common mesenchymal tumors of the GI tract and account for approximately 25% of esophageal mesenchymal neoplasms (37). One institution suggested that esophageal GISTs are slightly less common than esophageal leiomyomas, which constitute 42% of pathologically proven mesenchymal tumors, based on data accumulated over 20 years (38).

Fig. 13. Idiopathic muscular hypertrophy in a 25-year-old male.
A. An axial contrast-enhanced CT image shows circumferential thickening (arrow) of the middle esophagus.
B. Endoscopic ultrasonography image and schematic show prominent thickening (arrows) of the hypoechoic muscularis propria layer.

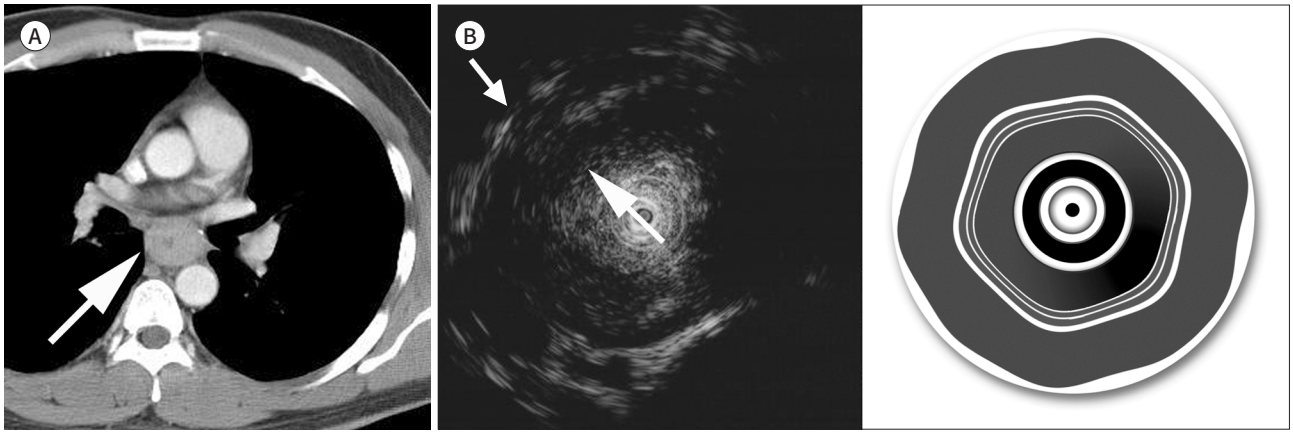
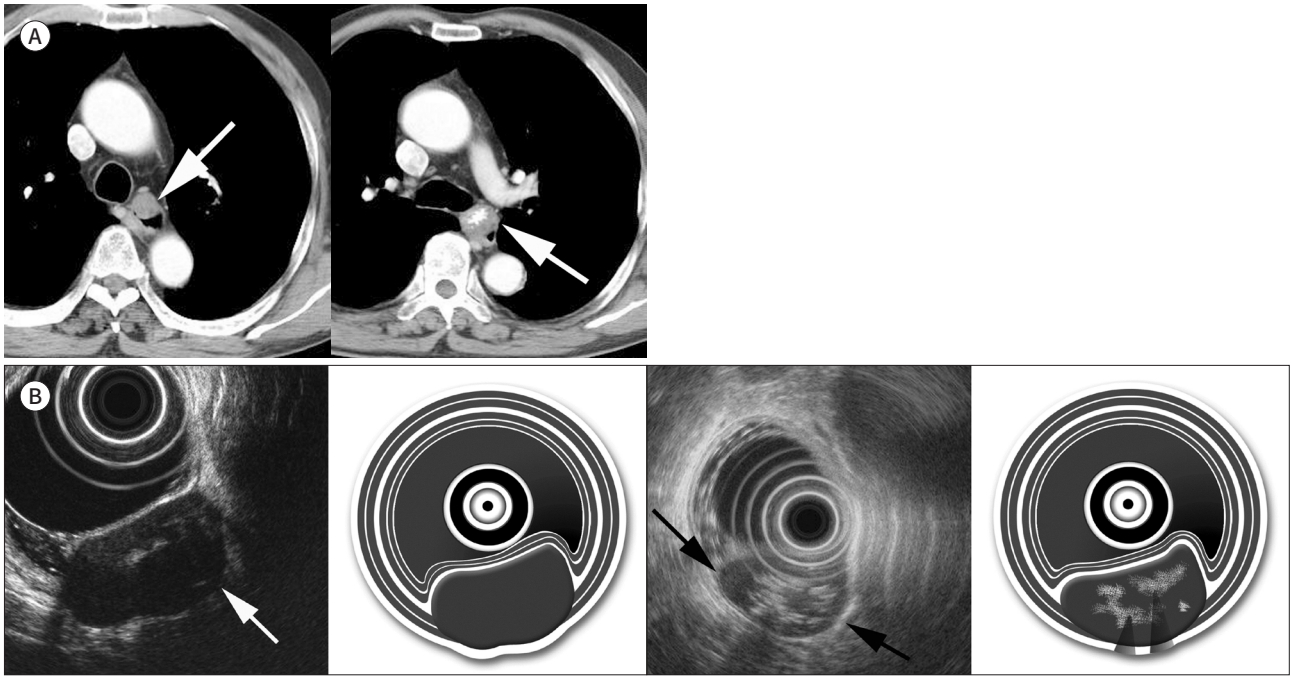


Fig. 14. GIST and Leiomyoma with calcification in a 73-year-old male.
A. Axial contrast-enhanced CT images (the left image is superior to the right image) demonstrate two soft-tissue masses (arrows) in the middle esophagus. The distal mass exhibits central calcification (arrow in right).
B. Endoscopic ultrasonography image and schematic illustration of the proximal tumor show a well-demarcated, homogeneous, hypoechoic mass (arrow in 1st image) with a smooth margin that arose in the muscularis propria. This proximal tumor was confirmed as GIST via pathological examination (not shown). Endoscopic ultrasound image and schematic illustration of the distal tumor show a relatively homogeneous hypoechoic mass (arrows in 3rd image) with strong internal echoes that arose in the muscularis propria. This distal tumor was confirmed as leiomyoma through pathological examination (not shown).
GIST = gastrointestinal stromal tumor



Esophageal GISTs are most commonly located in the distal third of the esophagus (37, 38). Most patients were asymptomatic. However, a large esophageal GIST can lead to symptoms such as dysphagia (38). Unlike leiomyomas, esophageal GISTs have a known malignant potential that warrants serious consideration for surgical resection, treatment with tyrosine kinase inhibitors, or both, even in the absence of symptoms (38).

GISTs are typically large, hypervascular, enhancing masses on contrast-enhanced CT images, and are often heterogeneous because of necrosis, hemorrhage, or cystic degeneration (Fig. 14A). Ulcerations and fistulization to GI lumen are common. The endoscopic and EUS appearances of the esophageal GISTs and leiomyomas were similar (Fig. 14B). On endoscopy, benign GISTs surfaces are smooth, whereas ulceration or hemorrhage is observed on malignant GIST surfaces. EUS typically shows hypoechogenic masses originating from the muscularis propria or rarely from the muscularis mucosa. EUS features associated with malignant GISTs include size >30 mm, an irregular outer margin, and inhomogeneity with intratumoral cystic spaces (39).

DUPLICATION CYST

Esophageal duplication cysts account for 0.5%–2.5% of tumors or tumor-like lesions of the esophagus and approximately 20% of GI tract duplications (40).

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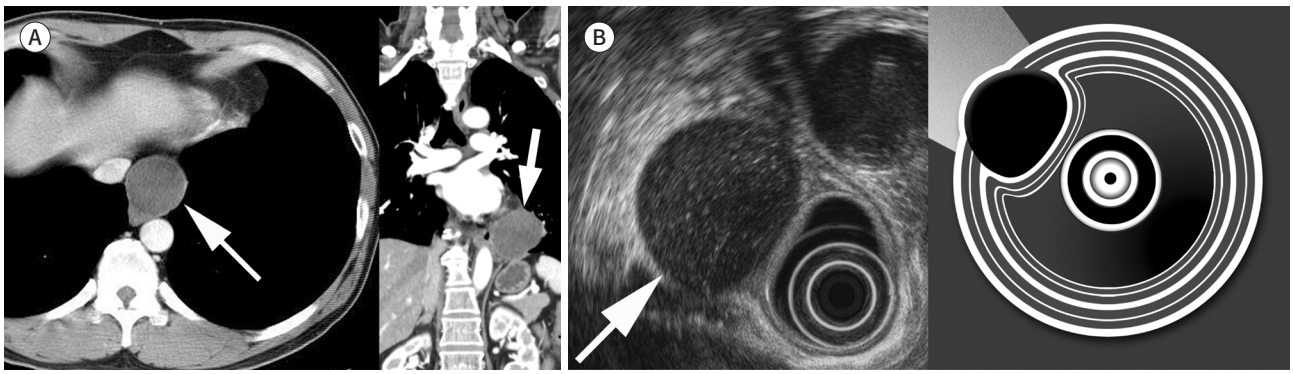
Duplication cysts may arise in the submucosal region or muscularis propria of the gut. Approximately 90% of cysts do not communicate with the esophageal lumen. Approximately 60% of duplication cysts occur in the lower third of the esophagus, leading to compressive dysphagia as the predominant presenting symptom. CT images showed homogeneous, hypoattenuated masses with smooth borders (Fig. 15A) (41). Esophageal cysts appear as anechoic masses with strong posterior acoustic enhancement in the submucosal or muscular propria layer on EUS (Fig. 15B) (20). Lesions have a smooth, well-defined border and are easily compressed by balloon pressure.

DIFFERENTIAL DIAGNOSIS OF ESOPHAGEAL DISEASES

When encountering a space-occupying lesion within the esophageal wall, the layer of the esophageal wall from which the lesion originates should be determined first to establish an imaging differential diagnosis (Fig. 16). To achieve this, it is important to be familiar with the normal echogenicity of the esophageal wall layers, as visualized using EUS. A hyperechoic superficial mucosa (superficial mucosa [epithelium] appears hypoechoic, but in low-frequency EUS, it appears hyperechoic due to the lumen-mucosa interface), hypoechoic deep mucosa, hyperechoic submucosa, hypoechoic muscular propria, and hyperechoic adventitia. After identifying the origin of the lesion using EUS, the lesion must be determined as focal or diffuse. For diffuse lesions, the possibility of esophagitis should be considered if observed in the mucosal layer, whereas idiopathic muscular hypertrophy should be considered if observed in the muscularis propria. For focal lesions, it is necessary to assess the echogenicity of the lesion observed on EUS to determine whether it is solid, contains fat or calcification, or is cystic. In the case of a hypoechoic solid mass, large, irregularly shaped lesions may raise the suspicion of malignancies such as esophageal cancer, metastasis, or malignant GIST. When evaluating malignancy, the invasion of surrounding organs and the presence of lymphadenopathy must be assessed. CT is a useful imaging modality in such cases because it provides informa-

Fig. 15. Esophageal duplication cyst in a 51-year-old male.
A. An axial contrast-enhanced CT image obtained at the level of the hepatic dome shows a well-defined, low attenuation mass (arrow) in the lower esophagus. A coronal contrast-enhanced CT image demonstrates a well-defined, low attenuation mass (arrow) in the lower esophagus.
B. Endoscopic ultrasonography image and schematic show a homogeneous anechoic mass (arrow) with posterior acoustic enhancement that arose in the muscularis propria layer.



tion regarding the involvement of the mediastinum, adjacent lymphadenopathy, and distant disease spread. CT is also useful for assessing the extent of vascular lesions such as varices or hemangiomas.

CONCLUSION

Various diseases can affect the esophagus. Although endoscopy with or without EUS has been the mainstay for investigating esophageal diseases, CT is also an important primary imaging tool that provides information about mediastinal involvement, adjacent lymphadenopathy, and the distant spread of the disease. These two modalities complement each other in the diagnosis of esophageal diseases. Although the EUS and CT findings of some abnormalities overlap, identifying the origin of the lesion along the layers of the esophageal wall and possessing knowledge of the typical imaging findings of EUS and CT help narrow the range of differential diagnoses (Table 3, Fig. 16).

Table 3. CT and Endoscopic Ultrasonographic Findings of Esophageal Lesions

Esophageal Lesions	CT Findings	Endoscopic Findings	Endoscopic Ultrasonographic Findings
Idiopathic eosinophilic esophagitis	Long segment, circumferential wall thickening	Concentric mucosal rings, linear furrows	Involve all layers, circumferential wall thickening
Papilloma	Sessile lesion	Single round, elevated, sessile, whitish or pinkish-colored lesion	Superficial mucosal layer, hyperechoic nodule confined to mucosa
Esophageal cancer	Focal wall thickening >5 mm, polypoid mass	Exophytic, polypoid mass, ulceration, Infiltration	Originate from the superficial mucosal layer and extend to involve the entire layer, heterogeneous hypoechoic mass
Granular cell tumor	Well defined mass	Grayish-white to yellow nodule or plaque	Deep mucosal layer or submucosal layer, hypoechoic solid mass
Fibrovascular polyp	Soft tissue attenuation or fat attenuation mass	Sausage shaped intraluminal mass with normal mucosa	Submucosal layer, well-defined hyperechoic mass
Lipoma	Well-defined low attenuation mass	Yellow, pliability, smooth surface	Submucosal layer, hyperechoic mass with a smooth border
Hemangioma	Well defined soft tissue mass with calcification	Bluish, compressible, protruding mass	Submucosal layer, anechoic to hypoechoic to isoechoic
Varcies	Wall thickening, protruding luminal mass	Dilated, tortous, serpentine structures, red sign	Submucosal layer, hypoechoic, serpentine, tubular lesions
Metastasis	Concentric thickening of wall	Normal mucosa	Submucosal layer, irregular, ill-defined, heterogeneous hypoechoic
Schwannoma	Homogeneous soft tissue mass	Submuscoal tumor with normal mucosa	Submucosa or muscular propria layer, nonspecific hypoechoic mass
Idiopathic muscular hypertrophy	Circumferential wall thickening	Normal	Muscular propria layer, thickening of hypoechoic muscularis propria
Leiomyoma	Well defined, homogeneous soft tissue mass	Well circumscribed round or oval mass with intact mucosa	Muscular propria layer, well defined, smooth margin, hypoechoic mass
GIST	Large, hypervascular enhancing mass	Well circumscribed round or oval mass with intact mucosa	Muscular propria layer, similar to leiomyoma
Duplication cyst	Homogeneous low attenuation mass	Compressible subepthelial mass	Muscularis propria or submucosal layer, anechoic with posterior acoustic enhancement

GIST = gastrointestinal stromal tumor

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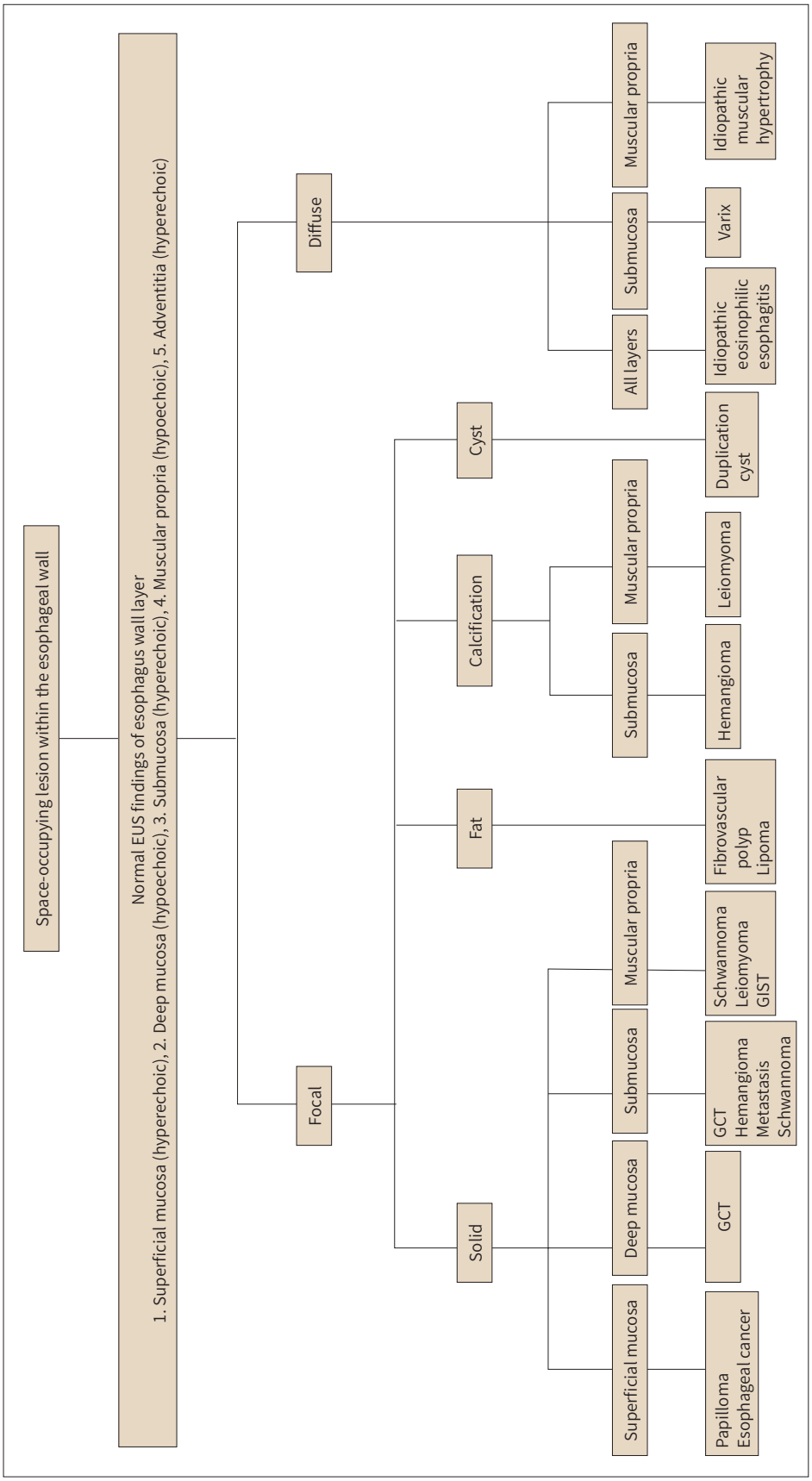

Fig. 16. Flow chart of differential diagnosis of esophageal disease with EUS findings.

EUS = endoscopic ultrasound, GCT = granular cell tumor

Author Contributions

Conceptualization, L.J.W., K.G.H., J.Y.J.; data curation, Y.S.M., Y.J.A.; formal analysis, J.Y.J.; investigation, L.J.W., K.G.H., J.Y.J.; supervision, J.Y.J.; writing—original draft, Y.S.M., L.J.W., J.Y.J.; and writing—review & editing, all authors.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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식도 질환의 내시경 초음파 및 전산화단층촬영 소견

윤수민[1] · 염정아[2] · 이지원[1] · 김광하[3] · 남경진[2] · 정연주[2]*

식도에는 다양한 질병이 발생한다. 장벽층에 관한 정확한 정보를 제공하는 내시경 초음파가 식도 질환 검사의 주요 수단이지만, 전산화단층촬영은 종격동 침범 여부, 주변 림프절 크기 증가, 원격 전이에 대한 정보를 얻을 수 있어 식도 질환의 진단에 중요한 영상 검사 중의 하나이다. 이 두 검사 방법은 식도 질환의 진단 및 평가에 상호 보완적이다. 영상의학과 의사는 내시경 초음파 검사 방법 및 그 영상 소견에 익숙하지 않은 경우가 많지만, 이를 잘 이해한다면 식도 질환의 감별 진단에 많은 도움을 받을 수 있다. 본 임상화보에서는 식도 질환이 식도벽의 어느 층에서 기원하는지에 따라 분류하고, 이들의 내시경 초음파 및 전산화단층촬영 영상 소견을 기술하고자 한다.

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