A variety of diseases involve the esophagus including esophagitis, benign or malignant tumors, varices, and esophageal perforation. We reviewed the thoracic CT of these various esophageal diseases, and classified them by similar CT findings. The CT findings were circumferential wall thickening, nodular wall thickening, abnormal luminal dilatation, fistula formation, and mass or mass like lesion. Although CT alone has limited diagnostic ability in esophageal disease, it may have an important role in diagnosing submucosal dissection, fistula, perforation, and intramural abscess.

**Index words :** Esophagus, abnormalities
Esophagus, diseases
Esophagus, CT

CT is a widely used diagnostic modality for diseases of various organs. CT has an advantage in detection and assessment of involvement of adjacent structures or distant spread in esophageal diseases. However, CT alone has limited ability to differentiate some esophageal diseases such as esophagitis, and carcinoma, because it may provide little information about the mucosa. For this reason, CT has not been used as a method of choice in diagnosing esophageal disease. In this article, we illustrate the spectrum of esophageal abnormalities according to the thoracic CT features classified into several patterns.

**Benign Circumferential Wall Thickening**

The apparent thickness of the esophageal wall at CT varies according to the degree of distention, and a thickness of 3 mm or more has been considered abnormal. Berkovich et al. (1) suggested that 5 mm was a more useful threshold for esophageal wall thickening in patients with esophagitis in their study.

**Esophagitis**

Esophageal wall thickening is a nonspecific response to various conditions involving the esophagus. Wall thickening in esophagitis tends to be concentric and circumferential rather than eccentric or asymmetric. Esophagitis involves a relatively long segment of the esophagus (1). It is not possible to suggest a specific cause of esophagitis only on the basis of CT findings.

**Caustic esophagitis**

Caustic injury to the esophagus may be caused by ingestion of alkali, acids, ammonium chloride, phenols,
silver nitrate, and a variety of other common household products. Caustic esophagitis is characterized pathologically by three phases of injury: an acute necrotic phase (1-4 days), an ulceration-granulation phase (3-5 days), and a final phase of cicatrization and scarring (from 3 weeks after ingestion). CT depicts diffuse wall thickening in the acute and ulceration phases and narrowing or obliteration of the esophageal lumen in the cicatrization phase.

**Radiation esophagitis**

Malignant tumors involving the lungs, mediastinum, or thoracic spine are often treated with high-dose, external beam radiation (Fig. 1). The major limiting factor with this form of treatment is esophageal damage by ionizing radiation. Total doses of 4500 to 6000 rad may lead to severe esophagitis with irreversible damage and stricture formation. Smaller doses (2000 to 4500 rad) may cause a self-limited esophagitis without permanent sequelae. Radiation esophagitis may be diagnosed by abnormal esophageal wall thickening within a known radiation portal.

**Acute graft-versus-host disease (GVHD)**

GVHD is an immunologic disorder in which immunocompetent donor lymphocytes react against antigenic differences in host tissues resulting in severe tissue damage. Acute GVHD presents within the first 100 days of allogeneic bone marrow transplantation and is one of the major complications of this procedure. The skin, gastrointestinal tract, and liver are the principal targeted organs in patients with acute GVHD. The immunologic process causes bulla formation, followed by desquamation and sloughing of esophageal mucosa with subsequent stricture formation. Kalantari et al. (2) reported several CT features of acute gastrointestinal GVHD including bowel wall thickening, mucosal or serosal enhancement and bowel dilatation.

**Nodular Wall Thickening**

**Varices**

Esophageal varices are usually caused by portal hypertension in patients with cirrhosis or other liver diseases. Because increased portal venous pressure leads to upward venous flow via dilated esophageal collaterals to the superior vena cava, these varices are called uphill varices. The apparent thickness of the esophageal wall measured by CT varies according to the degree of distention. Esophageal varices may be recognized on CT scans by a thickened, lobulated esophageal wall containing round or serpentine structures that have homogeneous attenuation and enhancement with contrast material to the same degree as adjacent vessels (3) (Fig. 2).

**Abnormal Esophageal Dilatation**

**Achalasia**

Achalasia is a rare motor disorder resulting in aperistalsis of the lower esophagus and inadequate relaxation of the lower esophageal sphincter. The pathogenesis of achalasia remains obscure. Ganglionic cells are decreased in number in achalasia, but a narrow aganglionic segment is not present. Esophagography reveals, typi-
cally, that the lower end of the esophagus has a smooth, tapered, beak-like appearance at the level of the esophageal hiatus. Rabushka et al. (4) retrospectively reviewed the CT scans of nine achalasia patients where moderate to marked esophageal dilatation (mean diameter: 4.35 cm at the carinal level), but normal wall thickness was demonstrated (Fig. 3). In uncomplicated achalasia, CT provides little more information than other studies including esophagogram, manometry, nuclear medicine swallow and endoscopy. However, in complicated cases [pulmonary aspiration, secondary carcinoma, and iatrogenic esophageal perforation], CT may be helpful in confirming the diagnosis or in detecting atypical features that may be indicate the presence of other diseases [4].

**Diverticula**

Esophageal diverticula may be classified by their location or by their mechanism of formation. The most common locations are the pharyngoesophageal junction (Zenker diverticulum), the midesophagus, and the distal esophagus just above the gastroesophageal junction (epiphrenic diverticulum). Diverticula may be formed either by pulsion due to increased intraluminal

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**Fig. 3. Achalasia in a 64-year-old woman.**
A. CT scan shows esophageal dilatation with normal wall thickness.
B. Esophagogram reveals smooth, tapered lower end of esophagus at the level of the esophageal hiatus [arrows].

**Fig. 4. Esophageal diverticulum in a 76-year-old woman.**
A. CT scan shows focal air-density [arrows] adjacent to esophageal lumen.
B. Esophagogram reveals diverticulum at upper esophagus.
esophageal pressure or by traction due to fibrosis in adjacent periesophageal tissue. Pulsion diverticula are much more common and usually have a rounded contour and a wide neck and are frequently multiple. Because they contain no muscle in their wall, pulsion diverticula tend to remain filled after the esophagus has emptied of barium (Fig. 4). Traction diverticula, on the other hand, contain all layers of the esophageal wall, including muscle. When the esophagus collapses, traction diverticula tend to empty on esophagogram [3].

Fig. 5. Submucosal esophageal dissection in a 74-year-old man without definite etiology.
A, B. CT scan shows double esophageal lumen (asterisks).
C. Endoscopy reveals mucosal bridge with double lumen.

Fig. 6. Leiomyoma in a 24-year-old man.
A. CT scan shows homogeneous soft tissue mass with displaced endoluminal air.
B. The barium study shows a mass with a smooth surface and slightly obtuse borders characteristic of submucosal mass.
C. Endoscopic image shows submucosal mass with intact overlying mucosa.
**Scleroderma**

Scleroderma is characterized by fibrosis and degenerative changes in the skin, synovium, and parenchyma of multiple organs, including the esophagus. Esophageal involvement occurs in most patients with scleroderma, with the smooth muscle segment and lower esophageal sphincter being predominantly affected. Esophagogram shows the absence of peristalsis in the smooth muscle portion of the esophagus with esophageal dilatation. Bhalla et al. (5) retrospectively reviewed the HRCT scans of 225 patients with scleroderma and detected asymptomatic esophageal dilatation in 80% of patients. CT potentially could be useful in detecting asymptomatic thoracic esophageal dilatation/flaccidity in patients who have scleroderma lung disease.

**Intramural esophageal dissection (Intramural esophageal perforation)**

Submucosal dissection of the esophagus is a rare esophageal disorder which reveals characteristic endoscopic features of mucosal bridge (Fig. 5). The etiology of this condition is attributed to vomiting, eating, trauma from falling, and anticoagulation, or as the result of an intramural abscess caused by a foreign body (6).

**Esophageal Mass or Mass Like Lesion**

**Benign causes**

**Leiomyoma**

Leiomyoma is the most common benign esophageal tumor, accounting for more than 50% of all such tumors. About 60% of these tumors are located in the distal third of the esophagus, 30% in the middle third, and 10% in the proximal third (3). Most patients with esophageal leiomyomas are asymptomatic. In contrast to gastric leiomyomas, esophageal leiomyomas rarely ulcerate, so that upper gastrointestinal bleeding is extremely uncommon. On CT, such tumors usually appear as homogeneous soft tissue lesions (Fig. 6), though differentiation from other esophageal tumors (fibromas, neurofibromas, or hemangiomas) is difficult.

**Schwannoma**

Recent advances in immunohistological procedures have shown that gastrointestinal stromal tumors (GISTs) form a heterogeneous group. Schwannoma has been confirmed as a distinctive entity among GISTs by immunohistochemical techniques. Positive immunohistochemical staining for S-100 protein and negative staining for smooth muscle markers such as actin and desmin confirm that the tumor originates from the nerve sheath.

Esophageal schwannoma is extremely rare and can occur anywhere in esophagus. The preoperative differentiation of schwannomas from other submucosal tumors can be very difficult. A barium esophagogram reveals a large smooth, polypoid-filling defect, and CT scans depict a mediastinal mass (3) (Fig. 7).

**Duplication cyst**

Duplications of the esophagus constitute approximately 20% of all gastrointestinal tract duplications. Ectopic gastric mucosa was found in 43%. They result from abnormal embryologic development in which nests of
cells are sequestered from the primitive foregut, and may be classified as either cystic or, less commonly, tubular duplications. Although most duplication cysts are noncommunicating, tubular duplications may occasionally communicate directly with the esophageal lumen. Esophagography may demonstrate displacement of the esophagus by a paraesophageal mass or, more characteristically, an intramural, extramucosal mass. CT scans of cystic esophageal duplication depict a homogeneous mass with low attenuation and a smooth border (3) (Fig. 8).

**Lymphangioma**

Esophageal lymphangioma is extremely rare. This tumor can be recognized by its projection into the lumen, pale color, overlying normal mucosa, cystic translucency, and its deformation under pressure with the endoscope (7). CT shows low dense intramural mass, so it can be differentiated from other solid submucosal masses (Fig. 9). In our case, endoscopic ultrasound shows a cystic mass with internal septation, suggesting differentiation from other solid mass. A definitive diagnosis of lymphangioma is obtained by surgical or endoscopic excision.

**Intramural abscess due to tuberculosis or foreign body.**

Esophageal tuberculosis is a rare entity that is found in an estimated 0.15% of patients who die of tuberculosis. Two cases of reported esophageal tuberculosis presented with discrete intramural abscess with no evidence of pulmonary tuberculosis (8) (Fig. 10). Intramural abscess due to foreign body (Fig. 11) may mimic tuberculosis On CT.

**Malignant causes**

**Esophageal carcinoma**

Esophageal carcinoma may invade local, regional, or distant structures by various pathways, including direct extension, lymphatic spread, and hematogeneous metastases. Because the esophagus lacks a serosa and is attached to neighboring structures by only loose adventitia, there is no anatomic barrier to prevent the spread of tumor into the adjacent mediastinum. In the past, no reliable preoperative tests were available for detecting periesophageal invasion or regional lymph node involvement by esophageal carcinoma. However, the emergence of CT, MR imaging, endoscopic ultrasonography (EUS), and positron emission tomography [PET] has had a major impact on the preoperative evaluation of esophageal carcinoma. CT and MR imaging are both capable of detecting mediastinal invasion (Fig. 12), mediastinal adenopathy, and distant metastases from esophageal carcinoma. CT is currently the best noninvasive test for staging patients with esophageal carcinoma.
However, it is important to recognize the limitations of CT in evaluation of mediastinal invasion.

**Small cell carcinoma**

Primary small cell carcinoma of the esophagus is a rare but aggressive malignant tumor characterized by early metastases and a rapidly fatal course. Initial symptoms of small cell carcinoma of the esophagus do not differ from those of more frequent histologic forms. The most common symptoms are dysphagia and weight loss. However, the clinical presentation almost always includes more advanced disease.Nearly 75% of patients are found to have metastases at the time of diagnosis. These patients have a dismal prognosis, with an average survival of 6 months from the time of diagnosis. Small cell carcinoma may appear as an ulcerated polypoid
mass in the middle or in the lower one third of the esophagus [Fig. 13].

**Malignant melanoma**

Primary malignant melanoma of the esophagus is an extremely rare disease, accounting for 0.1-0.2% of all neoplasms of the esophagus. As in the skin, esophageal melanoma presumably develops because of malignant degeneration of pre-existing melanocytes. Approximately 30-40% of patients have lymph node or distant metastases present at the time of diagnosis. The overall 5-year survival is 4.2% with only about 30% of patients surviving more than 1 year after initial diagnosis. These tumors can sometimes be recognized at endoscopy as darkly pigmented masses, but pigmentation is not always apparent on visual inspection. Esophageal melanomas have strikingly similar findings on barium studies, appearing as bulky, polypoid intraluminal masses that expand the esophagus without causing obstruction. CT may also reveal large soft tissue masses expanding the esophagus (Fig. 14). These findings occur because melanoma tends to grow intraluminally along the longitudinal axis of the esophagus, producing a polypoid mass that widens the lumen as it enlarges. Most esophageal melanomas are located in the lower half of the esophagus, probably because of the greater concentration of melanocytes in this region.

**Leiomyosarcoma**

Leiomyosarcomas of the esophagus are rare low-grade malignant tumors characterized by slow growth and late metastases. They are usually located in the distal two thirds of the esophagus because this portion is lined by smooth muscle. Because of their relatively slow growth rates, esophageal leiomyosarcomas have a better prognosis than squamous cell carcinomas. Esophageal leiomyosarcomas are characterized on CT by heterogeneous masses containing large exophytic components, central areas of low density, and extraluminal gas or contrast material within the tumor (presumably because of necrosis and cavitation) [Fig. 15].

**Fistulas**

**Esophageal-airway fistula**

In adults, esophageal fistulas are usually acquired lesions. They can occur as a complication of intrathoracic malignancies (60%), prolonged tracheal intubation, esophageal instrumentation (including endoscopy and esophageal tube placement), and infection or trauma. Most esophageal-airway fistulas result from direct inva-
sion of the tracheobronchial tree by advanced esophageal carcinomas. Tracheoesophageal or esophago-bronchial fistulas have been reported in 5 to 10% of patients with esophageal cancer. The fistulas tend to occur after radiation therapy, presumably because radiation-induced tumor necrosis accelerates fistula formation. Patients with esophageal-airway fistulas often present with paroxysmal coughing after ingestion of liquids. Diagnosis is usually made with a fluoroscopic contrast-enhanced study. However, CT may be helpful in the diagnosis of a fistulous tract.

**Esophago-nodal fistula**

The most common cause of esophageal tuberculosis is secondary involvement from adjacent tuberculous lymphadenitis. When tuberculous lymph nodes erode the adjacent esophageal or bronchial wall, esophago-nodal or esophago-bronchial fistulas may be formed. Esophago-nodal fistula predominantly occurs at subcarinal areas, possibly due to anatomic proximity of the esophagus to diseased nodes (9) (Fig. 16). Esophageal perforation caused by tuberculous esophago-mediastinal fistulas may close uneventfully during antituberculous therapy.

**Esophago-pleural fistula**

Because of the close anatomic relationship between the esophagus and pleura, fistulas may develop between these structures due to a variety of benign and malignant diseases. Esophago-pleural fistulas are usually caused by previous surgery, esophageal instrumentation, radiation, or advanced esophageal carcinoma directly invading the pleural space. The radiographic findings that suggest the occurrence of esophago-pleural fistula include pleural effusion, pneumothorax, or hydro pneumothorax. When an esophago-pleural fistula is suspected, a study using water-soluble contrast medium should be performed to confirm the presence of a fistula and to determine its precise location. The site of communication between the pleural space and the esophagus can often be seen on CT. CT has been regarded as the imaging method of choice for the evaluation of suspected esophago-pleural fistula.

**Spontaneous Esophageal Perforation**

*(Boerhaave’s Syndrome)*

Most cases result from violent retching or vomiting, usually after an alcoholic binge. Perforation usually occurs as 1 to 4 cm, vertically oriented, linear tears on the left lateral wall of the distal esophagus just above the gastroesophageal junction.

Chest radiographic detection of esophageal perforation relies on the presence of indirect signs, including pneumomediastinum, left-side pneumothorax, and pleural effusion. The diagnosis of perforated esophagus should be established if the CT scan demonstrates (Fig. 17): (a) air in the soft tissues of the mediastinum surrounding the esophagus, (b) abscess cavities adjacent to the esophagus in either the pleural space or mediastinum or (c) actual communication of an air-filled esophagus with an adjacent mediastinal or paramediastinal air-fluid collection (2, 3). A major limitation of CT is its frequent inability to locate the exact site of perforation. When any of above CT signs are present, a contrast esophagogram should be obtained immediately to confirm the diagnosis and to determine the location of the perforation. Esophagogram may be normal in 10 per-

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**Fig. 16.** Esophago-nodal fistula in a 37-year-old man with tuberculous lymphadenitis. CT scan shows a small gas collection in the subcarinal lymph nodes. Esophageal gas pouches found anterolaterally into the subcarinal node demonstrate the fistula.

**Fig. 17.** Boerhaave’s syndrome in a 45-year-old man. CT scans through the lower thorax reveal air and low density fluid in the posterior mediastinum. Bilateral pleural effusion and consolidation in the left lower lobe are also noted.
cent, and in these cases the diagnosis must be based solely on the history and physical examinations and may be supplemented by the CT findings. Fadoo et al. (10) reported a CT technique which uses low-osmolar IV contrast material as the oral agent (Helical CT esophagography) to be a useful method for the evaluation of esophageal perforation in seriously ill patients and may substitute for fluoroscopic esophagography.

Hernia

The most common abnormalities identified are dehiscence of the diaphragmatic crura and stretching of the phrenico-esophageal ligament. These findings manifest as widening of the esophageal hiatus on cross-section, identifiable whenever the medial margins of the diaphragmatic crura are not tightly opposed.

Although CT has limitation for evaluation of gastrointestinal tract, it seems to be very useful in assessment of various esophageal diseases, especially extramucosal lesions such as intramural abscess, fistula, and perforation. CT can also assess secondary esophageal lesions associated with other disease in the thorax.

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References