



COMPUTED TOMOGRAPHY IN CARCINOMA ESOPHAGUS -A PICTORIAL REVIEW

Radiology

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ABSTRACT

Cancer esophagus is the commonest malignancy encountered in our Oncology clinic. Majority are squamous cell type even those involving the gastroesophageal junction. Computed tomography (CT) has been the standard imaging used following histological diagnosis of esophageal malignancy. The main role of CT is to stage the disease so as to determine the appropriate therapy. Our aim is to present a spectrum of CT imaging findings in patients with proven cancer esophagus and also give a glimpse on the post therapy imaging response.

KEYWORDS

Cancer esophagus, Computed tomography, RECIST

INTRODUCTION

With about 572,000 new cases and 508,000 deaths in 2018, esophageal cancer is the 7th most common cause of cancer morbidity and the 6th most common cause of cancer-related death worldwide(1).

The esophagus traverses three anatomic compartments: cervical, thoracic, and abdominal.

The thoracic esophagus is divided arbitrarily into equal thirds: upper, middle, and lower. The cervical esophagus lies in the neck, bordered superiorly by the hypopharynx and inferiorly by the thoracic inlet, which lies at the level of the sternal notch. The upper thoracic esophagus is bordered superiorly by the thoracic inlet and inferiorly by the lower border of the azygos vein. The middle thoracic esophagus is bordered superiorly by the lower border of the azygos vein and inferiorly by the lower border of the inferior pulmonary vein. The lower thoracic esophagus is bordered superiorly by the lower border of the inferior pulmonary vein and inferiorly by the stomach.

Cancers involving the esophago-gastric junction (EGJ) that have their epicenter within the proximal 2 cm of the cardia (Siewert types I/II) are staged as esophageal cancers. Cancers whose epicenter is more than 2 cm distal from the EGJ, even if the EGJ is involved, are staged using the stomach cancer TNM and stage groupings. The site of cancer is important in relation to the adjacent structures than to its actual position.

The esophageal wall has three layers: mucosa, submucosa, and muscularis propria. There is no serosa; rather, adventitia (periesophageal connective tissue) lies directly on the muscularis propria(2).

Esophageal lymphatic drainage is intramural and longitudinal. The lymphatic network within the esophagus is concentrated in the submucosa permitting early lymphatic metastases from even superficial cancers (3). The longitudinal nature of the submucosal lymphatic plexus permits lymphatic metastases orthogonal to depth of tumor invasion(4). Thus the site of cancer and the draining lymph nodes from it may not match(2).

Squamous cell carcinoma (SCC) and adenocarcinoma are the two

most common histology encountered in cancer of the esophagus. At our institute, 92 % of cancer esophagus are of squamous variety even those involving the gastro-esophageal junction(5).

Upper gastro-intestinal endoscopy (UGIE) is the primary investigating tool in the diagnosis of cancer esophagus. It provides information on cancer location and tissue to determine the cell type and histologic grade of the tumor.

CT of the chest and abdomen with oral and intravenous contrast frequently is the initial imaging modality used to determine the proximity of the tumor to other structures, as well as the cN and cM categories. PET/CT with FDG is used to further refine cN category away from the primary tumor, and is more sensitive than CT for determining cM category(6-9). We performed CT in all our patients due to unavailability of PET/CT at our institute.

CT protocol

CT was performed on a 128 slice multidetector CT scanner - SOMATOM Definition AS+, Siemens, Erlangen, Germany. Patient preparation included overnight fasting. To achieve adequate esophageal distension, each patient was given a mouthful of oral contrast to be swallowed during the arterial phase. CT is obtained from the neck till the pelvis. Images are obtained in the arterial and portal venous phase after injecting 70-80 ml of nonionic contrast medium (Iopromide 370mg/ml; Bayer AG, Germany) intravenously using a power injector at the flow rate of 3.5-4 ml/s. CT parameters used are rotation time=0.5 s, section thickness and intervals=5 mm, pitch=1.5, kVp=120, mAs=200, matrix=512 × 512 for image acquisition. Images were reconstructed using 1mm slice thickness. Coronal and sagittal reformations were reconstructed from the axial acquisition.

Staging of Primary Esophageal Carcinoma

T Staging:

The recommendations of the 8th edition of the AJCC Cancer staging for carcinoma esophagus are briefly described here. Malignant cells confined to the esophageal epithelium are categorized as Tis (high-grade dysplasia). Cancers confined to the mucosa are T1a (intramucosal), and those that invade beyond, but are confined to the submucosa, are T1b (submucosal). Cancers confined to the muscularis propria are T2. Cancers invading the adventitia are T3. Cancers

invading adjacent structures are T4, which are subcategorized into T4a and T4b. Infiltration into pleura, pericardium, azygous vein, diaphragm or peritoneum are staged as T4a whereas involvement of aorta, vertebral body and airway constitutes T4b tumour(2).

T staging is determined the depth of penetration of the esophageal wall and is best assessed by endoscopic ultrasound (EUS). CT has a limited ability to accurately distinguish T1, T2 and T3 diseases (10). T3 disease is seen on CT as periesophageal fat infiltration (Fig.1)(11). Exclusion of T4 disease, as indicated by the preservation of fat planes between the esophageal cancer and adjacent structures, is the most important role of CT in the determination of T status(12).

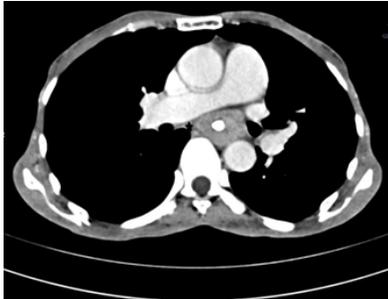


Fig 1. 50 year old female with proven squamous cell carcinoma of the esophagus with T3 disease.

Axial section at the level of right pulmonary artery showing circumferential thickening at mid thoracic esophagus with periesophageal fat infiltration (*). There is maintained fat plane with the right pulmonary artery and descending thoracic aorta. We perform CT in a patient with proven squamous cell carcinoma of the esophagus where UGIE showed rough mucosa at 30-34cm. No obvious thickening or growth noted in that region on CT scan (Fig 2A). Post operative specimen revealed squamous cell carcinoma infiltrating upto the submucosa suggestive of T1b disease (Fig.2B).



Fig 2 A, B. 58 year old female with proven squamous cell carcinoma of the esophagus at 30-34cm with T1b disease.

Sagittal MPR(A) reveals no obvious thickening along the esophagus (arrow). B. Photomicrograph(x100) of the post operative specimen reveal well differentiated squamous cell carcinoma(*) infiltrating upto the submucosa (arrow).

The CT criteria for local invasion include (a) loss of fat planes between the tumor and adjacent structures in the mediastinum, and (b) displacement or indentation of other mediastinal structures. Pericardial invasion is suspected if pericardial thickening, pericardial effusion, or indentation of the heart with loss of the pericardial fat plane is seen (Fig.3).

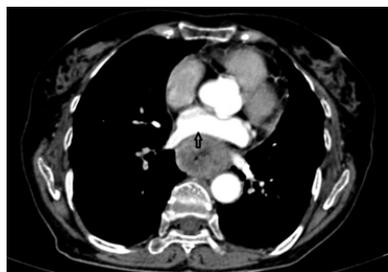


Fig 3. 56 year old female with proven squamous cell carcinoma of the esophagus with T4a disease.

Axial section at the level of the left atrium showing circumferential thickening of the mid thoracic esophagus with loss of fat plane with the pericardium (arrow).

Aortic invasion is suggested if 90° or more of the aorta is in contact with the tumor (Fig.4) or if there is obliteration of the triangular fat space between the esophagus, aorta, and spine adjacent to primary tumor (Fig.5).

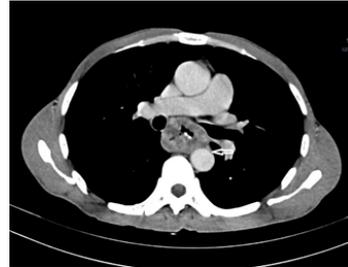


Fig 4. 43-year-old male with proven squamous cell carcinoma of the esophagus with T4b disease.

Axial section at the right pulmonary artery level showing circumferential thickening in the mid thoracic esophagus. The arc of contact of the mass with the descending aorta >90° (arrow).

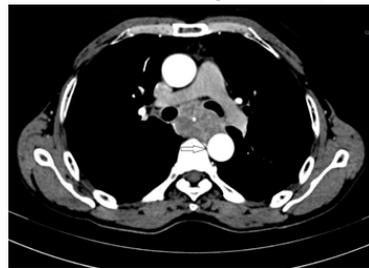


Fig 5. 43-year-old female with proven squamous cell carcinoma of the esophagus with T4b disease.

Axial section at the level of bifurcation of the pulmonary artery showing circumferential thickening involving the mid esophagus. Arc of contact with the descending aorta is >90° with obliteration of the triangular fat pad (arrow).

A tracheobronchial fistula or tumor extension into the airway lumen is a definite sign of tracheobronchial invasion (Fig.6A,6B,7)(12).

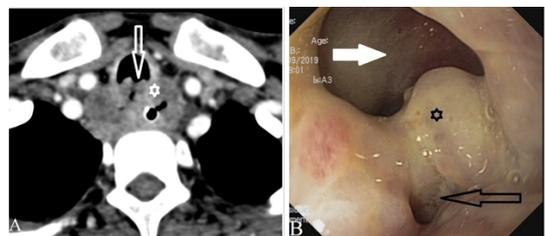


Fig 6 A, B. 33 year old male with proven squamous cell carcinoma of the esophagus and tracheo-esophageal fistula (T4b)

A. Axial section showing circumferential thickening (*) in the upper thoracic esophagus. Ryle's tube noted in situ. There is tumour infiltration into the tracheal lumen (arrow) suggestive of tracheo-esophageal fistula.

B. UGIE confirms the fistulous communication of the esophageal mass (*) with the trachea (hollow arrow). Solid arrow indicates the esophageal lumen.



Fig 7. 49 year old male with proven squamous cell carcinoma of the esophagus with contiguous pulmonary infiltration (T4b).

Axial section showing the esophageal mass infiltrating into the superior segment of right lower lobe (*). Randomly scattered nodules (arrow) are also seen in the lung parenchyma suggestive of metastases.

N Staging :

The nodal staging have been designated N1 (one to two) (Fig.8), N2 (three to six)(Fig.9), and N3 (seven or more)(Fig.10)(2).

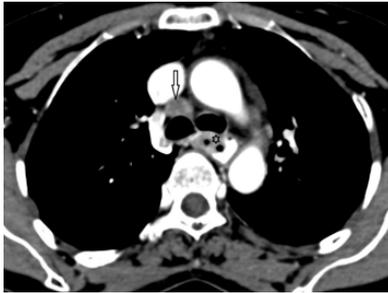


Fig 8. 57 year old male with proven squamous cell carcinoma of the esophagus with N1 disease.

Axial section showing eccentric thickening involving the mid thoracic esophagus (*) with maintained fat plane with the adjacent organ. A 1 cm solitary lymph node (arrow) is present in the precarinal location.

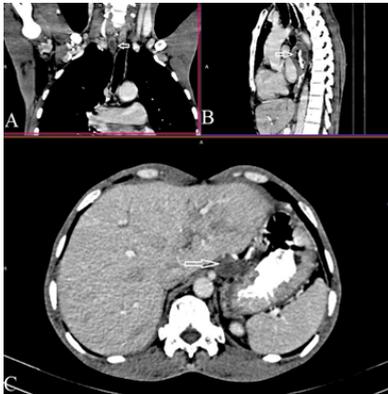


Fig 9 A-C. 43 year old male with proven squamous cell carcinoma of the esophagus with N2 disease.

A. Coronal MPR image reveal two enlarged lymphnodes in the lower cervical region, one of them having central necrosis (arrow). B. Sagittal MPR image showing circumferential thickening present in the mid thoracic esophagus.

C. Axial MPR image shows a solitary enlarged lymph node (arrow) in the gastrohepatic ligament with central necrosis.

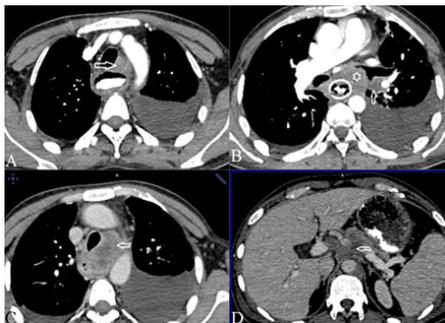


Fig 10 A-D. 47 year old male with proven squamous cell carcinoma of the esophagus with N3 disease.

Stack axial images showing conglomerate lymphnodes in the A. Left paratracheal(arrow), B. Left hilum(arrow), C. Aortopulmonary window (arrow) and D. Along the celiac axis(arrow) .Note made of the esophageal mass(*) and bilateral pleural effusion.

The specific regional lymph nodes for cancer esophagus are as follows:

- Right lower cervical paratracheal nodes
- Left lower cervical paratracheal nodes

- Right upper paratracheal nodes
- Left upper paratracheal nodes
- Right lower paratracheal nodes
- Left lower paratracheal nodes
- Subcarinal nodes
- Upper thoracic paraesophageal lymph nodes
- Lower thoracic paraesophageal lymph nodes
- Pulmonary ligament nodes
- Diaphragmatic nodes
- Paracardial nodes
- Left gastric nodes
- Common hepatic nodes

CT assessment of nodal status depends on the size of the lymph nodes. Most studies consider the common size criterion of 1 cm to be enlarged(10).We follow the 1cm short axis diameter to label a lymphnode as pathological. A study by Takizawa et al concluded that EUS is a more accurate technique than contrast.enhanced CT for detecting abnormal lymph nodes. But some metastatic lymph nodes in the neck and abdominal fields are only detectable by CT. Therefore, both EUS and CT should be undertaken for routine examination prior to treatment of esophageal cancer(13).

M Staging

Sites of distant metastases are those not in direct continuity with the esophagus, and include nonregional lymphnodes (M1)(2).

The most common sites of visceral metastases are the liver, lung, bones, and adrenal glands, whereas metastases to the brain, subcutaneous tissues, thyroid gland, skeletal muscles, and pancreas are rare(14).We encountered a variety of metastases to different organs which are illustrated below(Fig.11-16).Different authors have reported that FDG-PET is superior to CT in screening for distant metastases. In a study by Liberale et al, PET was more sensitive and accurate than CT in detecting distant metastases, but the difference was statistically significant only for sensitivities (p=0.009) (15).

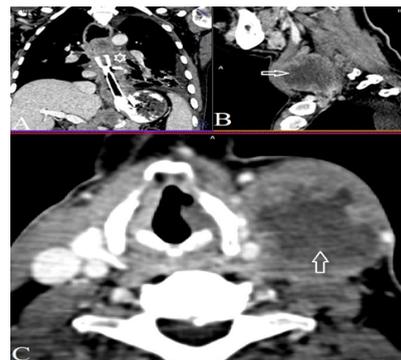


Fig 11 A-C. 47-year-old male with proven squamous cell carcinoma of the esophagus with non regional lymph-nodal metastases(M1).

A. Coronal MPR image showing long segment thickening involving the mid and distal esophagus up to the GE junction (*) with esophageal stent in situ. B & C. Sagittal and axial MPR reveals a large(5.7x3.8cm) lymph nodal mass (arrow) in level III and IV left cervical chain.

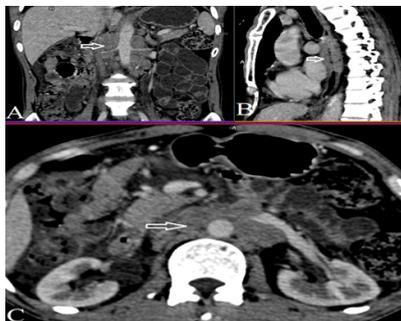


Fig 12 A-C. 50 year old male with proven squamous cell carcinoma of the esophagus with non regional lymph-nodal metastases (M1).

A & C. Coronal and axial MPR showing multiple conglomerate lymphnodes in the retroperitoneum extending below the renal vessels (arrow). B. Sagittal MPR reveals esophageal mass involving the mid lower thoracic esophagus (arrow).

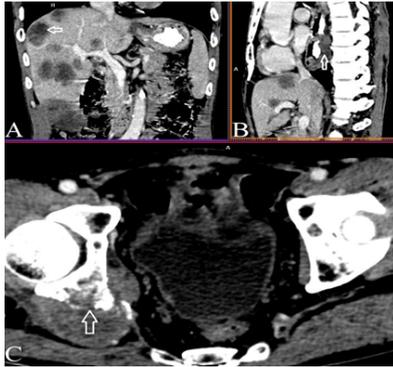


Fig 13 A-C. 51 year old male with proven squamous cell carcinoma of the esophagus with bone and hepatic metastases(M1).

A. Coronal MPR image showing multiple hepatic metastases (arrow) B. Sagittal MPR showing esophageal mass in the lower thoracic esophagus (arrow). C. Axial MPR showing bony metastasis involving posterior right acetabulum (arrow).

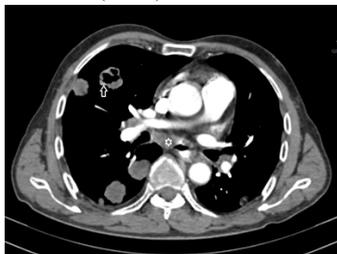


Fig 14. 67 year old male with proven squamous cell carcinoma of the esophagus with Cavitating pulmonary metastases(M1).

Axial section showing eccentric thickening (*) in mid esophagus with no adjacent organ invasion. There are multiple pulmonary nodules, one nodule in the right middle lobe showing cavitation (arrow).

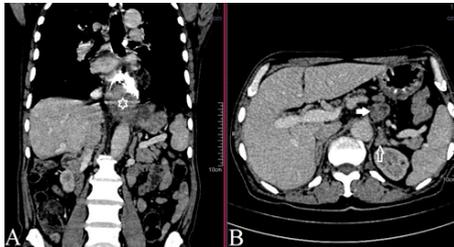


Fig 15 A, B. 64 year old male with proven adenocarcinoma of the gastro-esophageal junction with adrenal metastasis(M1).

A. Coronal MPR image showing mass (*) in the gastro-esophageal junction for a length of 6.7cm. B. Axial section showing a 2.3cm enlarged lymph node (solid white arrow) along the celiac axis. The left adrenal is enlarged and heterogeneous (hollow white arrow).

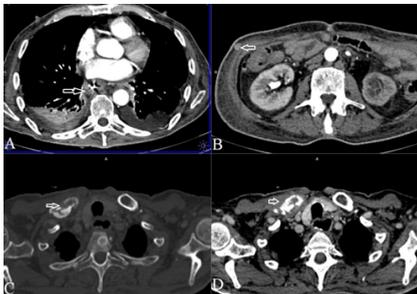


Fig 16 A-D. 65 year old male with Ca esophagus post esophagectomy with recurrent disease and disseminated metastases.

A. Axial section at the level of left atrium shows asymmetric thickening (arrow) of the pull up stomach. Note made of bilateral pleural effusion. B. A 1 cm subcutaneous nodule (arrow) is seen in the subcutaneous plane along the anterior abdominal wall. Biopsy revealed metastatic squamous cell carcinoma. C. Bone window shows a mixed lytic sclerotic lesion (arrow) involving the medial end of right clavicle. D. Mediastinal window shows soft tissue component (arrow) around the bony lesion.

Atypical presentation

Few of our patients had atypical presentation of the disease. One of them presented with metastatic disease in the abdomen with the esophageal lesion being very small and had no complain of dysphagia (Fig.17A,B,C,D).Orlicka also reported a similar case of a patient with esophageal squamous cell cancer presenting with a large abdominal mass(16).Another patient had history of chest pain with no dysphagia and an echocardiograph suggested an aortic dissection. An angiogram was subsequently advised which revealed a bulky esophageal mass encasing the descending thoracic aorta(Fig.18).

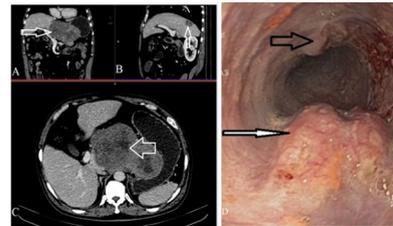


Fig 17 A-D. A 61 year old male presenting with a lump in the abdomen and no history of dysphagia.

A&C. Coronal & axial MPR images showing a large 15.1x10 cm mass (arrow) in the gastrohepatic region. Biopsy from the mass revealed metastatic SCC. B. A 2.8 cm heterogeneously enhancing lesion (arrow) present in segment VI of right lobe of liver. D. Upper gastrointestinal endoscopy (UGIE) reveal a ulcero-proliferative growth in the anterior wall (black hollow arrow) and posterior wall (solid arrow) extending from 29-31 cms from incisor. Biopsy revealed moderately differentiated SCC.



Fig 18. Suspected Aortic dissection on echocardiography in a 48 year old male complaining of chest pain with no history of dysphagia.

Axial section showing a mass (*) in the mid thoracic esophagus encasing the descending aorta. UGIE confirmed the findings and biopsy revealed SCC.

Synchronous malignancies

A characteristic feature of SCC is the occurrence of intramural metastases, which is encountered in up to 16% cases and usually associated with advanced stage and poor survival(17).In our institute, we encountered not only multiple skip lesions in the esophagus but also synchronous lesions in the aerodigestive tract (Fig.19) and other region as well (Fig. 20A,B,C).

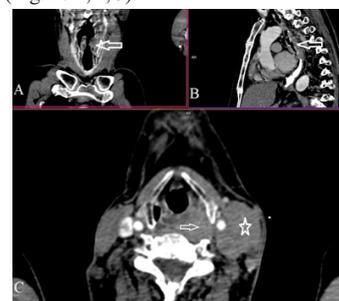


Figure 19 A-C. 55 year old male with proven squamous cell carcinoma in the left pyriform fossa and esophagus.

A&C. Coronal and axial MPR images showing a 1.7x1.2 cm mass (arrow) in the left pyriform fossa with a 4.1x 3.2 cm lymph nodal mass (*) in level III left cervical region. B. Sagittal MPR in the same patient showing circumferential thickening (arrow) in the mid esophagus for a length of 6.7 cms.

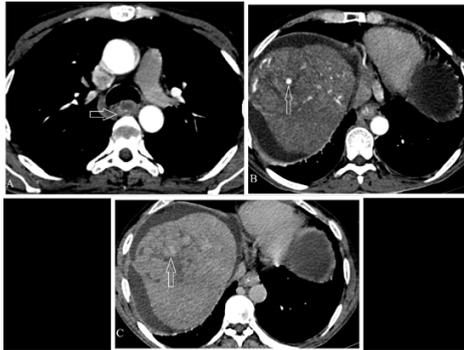


Figure 20 A-C. 47 year old male patient with proven squamous cell carcinoma of the esophagus with HCC.

A. Axial section at the level of pulmonary artery shows focal thickening (arrow) in the mid thoracic esophagus with maintained fat plane with the adjacent structures. B. Axial section at the upper abdomen reveals a 8.4x7.8cm mass (arrow) in segment VIII of right lobe of liver. The mass shows enhancement in the arterial phase with numerous arterial feeders within it. Note made of surface nodularity (*) of the visualized liver and perihaptic fluid.

C. Portal phase image at the same level shows washout of contrast in the tumour (arrow) suggestive of hepatocellular carcinoma. Alfa fetoprotein levels was 12018.

Co-existent Infection

We also reported cases where a patient with diagnosed Cancer esophagus had concomitant active tuberculosis (TB) in the lungs (Fig.21A,B,C,D). This is because pulmonary TB is very common in our population. The problem we faced with these patients is in deciding if the lymphnodes present are due to the infection or malignancy. If the lymphnodes show areas of calcification then it is likely old/treated tuberculosis in the past(18).

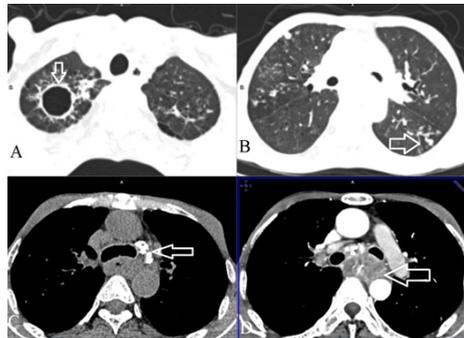


Fig.21 A-D.45 year old female with proven squamous cell carcinoma of the esophagus with sputum Acid fast bacilli positive suggestive of pulmonary tuberculosis.

A. Axial section reveals a thin walled cavitary lesion (arrow) in the apical segment of right upper lobe with adjacent consolidation and nodules. B. Centrilobular nodules with tree in bud pattern (arrow) noted in superior segment of left lower lobe. Few random nodules also seen in visualized right lung. C. Plain axial section shows few calcified lymphnodes (arrow) in the mediastinum. D. Axial section at the level of left pulmonary artery reveals a bulky mass (arrow) involving the mid thoracic esophagus.

Response evaluation criteria in solid tumours (RECIST)

The latest guidelines by the National Comprehensive Cancer Network (NCCN) states that T1/T2 lesion with no lymphnodes/metastatic disease require upfront surgery. However, T1/T2 lesions with lymphnodes involvement, T3 and T4a with or without lymphnodes (N1/N2) can undergo neoadjuvant chemotherapy/radiotherapy followed by surgery. Patients with T4b/N3/M0 disease can be

considered for chemotherapy plus radiotherapy. Palliative chemotherapy/radiotherapy is the treatment for M1 disease(19).

The RECIST version 1.1 describes a standard approach to solid tumour measurement and definitions for objective assessment of change in tumour size for use in adult and paediatric cancer following treatment. The definitions of the criteria used to determine objective tumour response for target lesions are given below:

- Complete Response (CR): Disappearance of all target lesions.
- Partial Response (PR): At least a 30% decrease in the sum of diameters of target lesions, taking as reference the baseline sum diameters (Fig.22A,B)
- Progressive Disease (PD): At least a 20% increase in the sum of diameters of target lesions. In addition to the relative increase of 20%, the sum must also demonstrate an absolute increase of at least 5 mm (Fig.23A,B)
- Stable Disease (SD): Neither sufficient shrinkage to qualify for PR nor sufficient increase to qualify for PD (Fig.24A,B) (20).

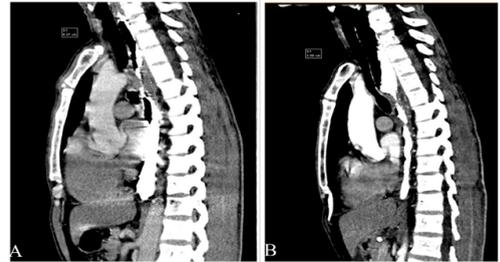


Figure 22(A,B) A 40 year old male with proven squamous cell carcinoma of the esophagus with "Partial response"

A: Pre neoadjuvant chemotherapy Sagittal MPR image showing circumferential thickening in the mid esophagus for a length of 6.3 cm. B: Post 3 cycles neoadjuvant chemotherapy Sagittal MPR image showing residual circumferential thickening in the mid esophagus for a length of 2.08 cm suggestive of partial response.

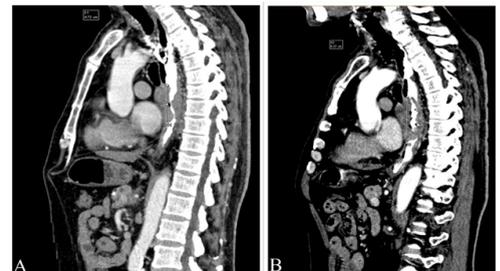


Figure 23 (A,B) A 64 year old male with proven squamous cell carcinoma of the esophagus with "Progressive disease"

A: Pre neo-adjuvant chemotherapy- Sagittal MPR showing circumferential thickening in the esophagus for a length of 4.7cm. B: Post 3 cycles neo-adjuvant chemotherapy-Sagittal MPR showing circumferential thickening in the esophagus for a length of 6.3cm suggestive of progressive disease.



Figure 24 (A,B) A 50 year old male with proven squamous cell carcinoma of the esophagus with "Stable" disease.

A: Pre neoadjuvant chemotherapy-Sagittal MPR image showing eccentric thickening in the lower thoracic esophagus for a length of 4.8cm. B: Post 3 cycles neoadjuvant chemotherapy- Sagittal MPR image showing eccentric thickening in the lower thoracic esophagus for a length of 4.4cm suggestive of stable disease.

In a review article by Westerterp, the author concluded that CT has poor accuracy for assessment of response to neoadjuvant therapy in esophageal cancer. EUS and FDG-PET have equivalent good accuracy, but FDG-PET is more widely feasible(21).

Due to the unavailability of PET CT in our institute, we routinely follow up our patients with conventional CT chest and abdomen post neoadjuvant therapy.

CONCLUSION

Computed tomography is an excellent modality in the diagnosis and staging of esophageal cancer. It is also useful in the assessment of post treatment response. At times it provides a definitive diagnosis when patients symptoms/initial investigation are not conclusive. It can also detect synchronous malignancies/infections in a single study.

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