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Original Research Article

Role of 128 slice-multi detector computed tomography in the imaging and staging of carcinoma oesophagus

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Abstract

Carcinoma oesophagus infiltrates locally involving adjacent lymph nodes and metastases widely by hematogenous spread. Esophageal cancers typically spread both by direct invasion and also via network of lymphatics. Hematogenous spread is more common in patients with advanced stages of diseases. Lungs and the liver have been regarded as the usual sites of hematogenous metastases. Out of all these patients, 78 patients were selected on the basis of histopathological examination (HPE) report showing the confirmed presence of carcinoma of the esophagus. After taking a properly informed written consent and complete history, a thorough clinical examination was done and these patients were subjected to CT scan. Clinical and radiological data from the study was recorded as per the proforma. Lymph nodal staging was done as per TNM staging in which N2 stage was seen maximum in 33 patients (42.3%) followed by N0 stage in 22 (28.2%) patients. 13 patients out of 78 were staged under N1 category (16.7%) and only 10 patients out of 78 (12.8%) showed N3 stage of lymph nodal spread. In our study out of 78 patients, 14 patients showed evidence of distant metastases (17.9%)-M1 stage. Rest 64 patients (81.1%)-M0 stage.

Keywords: Multidetector computed tomography, carcinoma oesophagus, TNM staging

Introduction

In general, the prognosis of oesophageal cancer is quite poor, because most patients present with advanced disease. By the time the first symptoms such as dysphagia start manifesting, cancer has already well progressed. The overall five-year survival rate is approximately 15%, with a life expectancy of less than one year [1].

Carcinoma oesophagus infiltrates locally involving adjacent lymph nodes and metastases widely by hematogenous spread. Esophageal cancers typically spread both by direct invasion and also via network of lymphatics. Hematogenous spread is more common in patients with advanced stages of diseases. Lungs and the liver have been regarded as the usual sites of hematogenous metastases. Oesophageal carcinoma is responsible for < 1% of all cancers and

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4-10% of all GI malignancies. MDCT provides valuable information regarding the local extent and is quite useful in determining optical management. Imaging studies play a key role in the detection, staging and post-treatment follow-up of patients. Proper staging of carcinoma of oesophagus is essential as treatment options and patient prognosis are directly related to staging at the time of presentation. Thus, helping surgeons to triage the patients and choose the line of management [2].

Squamous cells line the entire esophagus, so SCC can occur in any part of the esophagus, but it often arises in the upper half. Adenocarcinoma typically develops in specialized intestinal metaplasia (Barrett metaplasia) that develops as a result of gastro esophageal reflux disease (GERD); thus, adenocarcinoma typically arises in the lower half of the distal esophagus and often involves the esophago-gastric junction. Imaging techniques including Barium esophagography and CT scan are powerful tools in detection, diagnosis and assessing the stage of oesophageal carcinoma. The disease is diagnosed by biopsy done by endoscopy [3].

Oesophageal cancers are diagnosed by Upper GI Endoscopy with multiple biopsies. The introduction of endoscopic ultrasound has helped to a very large extent in determining the T and N stages of the disease. However, a CT scan is needed to identify lung and abdominal metastases. It also helps in assessing the local resectability of the growth by delineating the invasion into mediastinal structures. For assessment of response to neoadjuvant therapy in patients with oesophageal cancer.

Multidetector computerized tomography (MDCT) meant for diagnosing carcinoma oesophagus is the most useful technique of radio imaging modality for staging and management. It is an effective mode in determining the length, location, nature of characteristic lesions and in monitoring their alteration in size over time. It also depicts the severity of oesophageal cancer and is helpful for clinicians to plan and devise an appropriate treatment. It can also be used to detect distant metastasis. Its role is also very important both in diagnosis and prognosis. It is also extremely useful in monitoring patients who are treated surgically or pharmacologically, in order to evaluate response to therapy and the possibility of progression towards cancer [4].

For the last few years, rapid technological advances in cross-sectional imaging modalities have combined with the increased number of scanners to enable multiple new modes of imaging oesophageal carcinoma. Radiologists are skilled in interpreting CT scans in the axial plane, but the development of MDCT coupled with faster reconstruction hardware and software has developed a deep interest in viewing the oesophagus planes other than the axial plane. Therefore, the possible viability to conclude the fair results revealing axial imaging using MDCT equipped with a slice thickness of 16 mm cannot be ruled out.

The speed and higher resolution of MDCT enable the creation of 3D representations of complex data sets. As automated processing techniques mature, it may become routine to create a 3D representation of the oesophagus with a few mouse clicks. Computed tomography (CT) has become an indispensable tool for evaluating the oesophagus in both outpatient and emergency room settings [5, 6].

Methodology

Out of all these patients, 78 patients were selected on the basis of histopathological examination (HPE) report showing the confirmed presence of carcinoma of the esophagus. After taking a properly informed written consent and complete history, a thorough clinical examination was done and these patients were subjected to CT scan. Clinical and radiological data from the study was recorded as per the proforma.

Using the 128-Slice Computed Tomography scanner, the staging was done using the TNM staging system proposed by the American Joint Committee. Out of 78 patients, 32 patients underwent surgery for carcinoma esophagus and in them, CT findings were correlated with

the post-surgical findings wherever histopathological biopsy results were available.

Study design: Hospital-based cross-sectional study. All the patients with signs and symptoms of UGI disorder were carefully evaluated and a total of 78 patients who fulfilled the inclusion criteria of our study were selected in our study by the following methods.

Inclusion criteria

- Clinically suspected cases.
- Esophageal cancer patients detected by endoscopy and histopathology.

Exclusion criteria

- Chronic cough.
- Contraindication for contrast injection.
- Impaired renal function (serum creatinine >1.2 mg/dl).

Study tools

- Siemens SOMATOM Definition Edge 128 Slice Computed Tomography (MDCT) Machine.
- Automatic pump injector.
- Ionic and non-ionic contrast media.
- Case reporting form.

Results

Table 1: Wall attenuation of all lesions on MDCT scan done in the study

Wall Attenuation	Frequency	Percentage
Homogeneous	24	30.8
Heterogeneous	54	69.2

Most common type of wall attenuation was observed to be heterogenous in 54(69%) patients followed by homogenous in 24 (31%) patients.

Table 2: Lesion length of oesophageal lesions by MDCT (n=78)

Lesion length (cm)	Frequency	Percentage
<3	2	2.6
3-6	39	50.0
6-8	14	17.9
>8	23	29.5

Most of the patients had lesion lengths in the range of 3-6cm (50%), followed by 29.5% of the patients with lesion length > 8cm (29.5%)14 patients (18%) had lesion lengths in the range of 6- 8cm.

Table 3: Carcinoma esophagus 'T'-staging by MDCT

T-staging by MDCT	Frequency	Percentage
T1/T2	32	41.0%
T3	33	42.3%
T4	13	16.7%

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T staging was maximum in T3 stage patients 33 (42.3%) followed by 32 (41%) patients with T1/T2 staging and least number 13 (16.7%) patients accounted for T4 staging.

Table 4: 'N' staging of carcinoma oesophagus lesions on MDCT (n=78)

N-staging by MDCT	Frequency	Percentage
N0	22	28.2%
N1	13	16.7%
N2	33	42.3%
N3	10	12.8%

Lymph nodal staging was done as per TNM staging in which N2 stage was seen maximum in 33 patients (42.3%) followed by N0 stage in 22 (28.2%) patients. 13 patients out of 78 were staged under N1 category (16.7%) and only 10 patients out of 78 (12.8%) showed N3 stage of lymph nodal spread.

Table 5: 'M' staging of carcinoma oesophagus lesions on MDCT (n=78)

M-staging on MDCT	Frequency	Percentage
M0	64	82.1
M1	14	17.9

In our study out of 78 patients, 14 patients showed evidence of distant metastases (17.9%)-M1 stage. Rest 64 patients (81.1%)-M0 stage.

Table 6: Locations of distant metastases diagnosed on MDCT

Location of Metastasis(M)	Frequency	Percentage
Only Liver	7	8.97%
Only Lung	2	2.56%
Only bones	1	1.28%
Bone and liver	1	1.28%
Bone and lung	1	1.28%
Liver and spleen	1	1.28%
Lung and Adrenal	1	1.28%

Out of 14 patients showing distant metastasis. 7 patients showed metastasis to only the liver (8.9%) and 2 patients to only lung (2.5%), 1 patient to only bones. 1 patient (1.28%) showed both bone and liver metastases, 1 patient (1.28%) showed both bone and lung metastases, 1 patient (1.28%) showed both liver and spleen metastases and 1 patient (1.28%) showed both lung and suprarenal gland metastases. The most common location of distant metastasis was found to be the liver (11%) followed by lung (5.1%) and bones (3.8%).

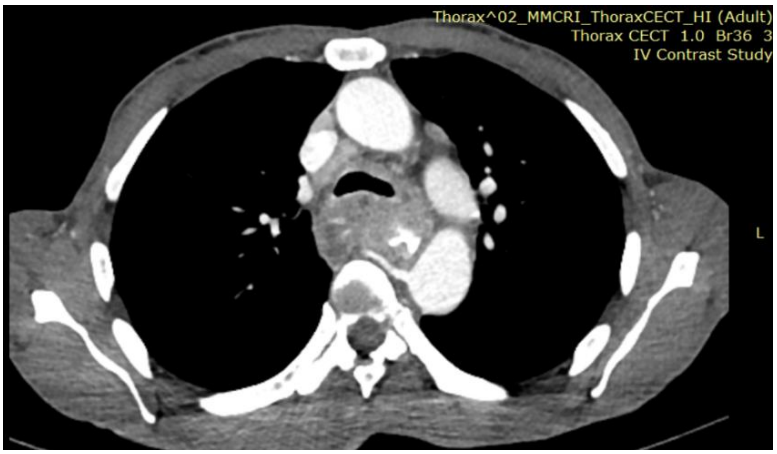
Table 7: TNM Staging of carcinoma oesophagus cases on MDCT (n=32)

Sr. No.	CT Staging (n =32)	No. of Cases	Percentage
1.	T1/2 N0 M0	1	3.12%
2.	T1/2 N1 M0	5	15.6%
3.	T1/2 N2 M0	1	3.12%
4.	T1/2 N3 M0	8	24.87%
5.	T3 N0 M0	4	12.5%
6.	T3 N1 M0	5	15.6%
7.	T3 N2 M0	7	21.87%
8.	T3 N3 M0	2	6.25%

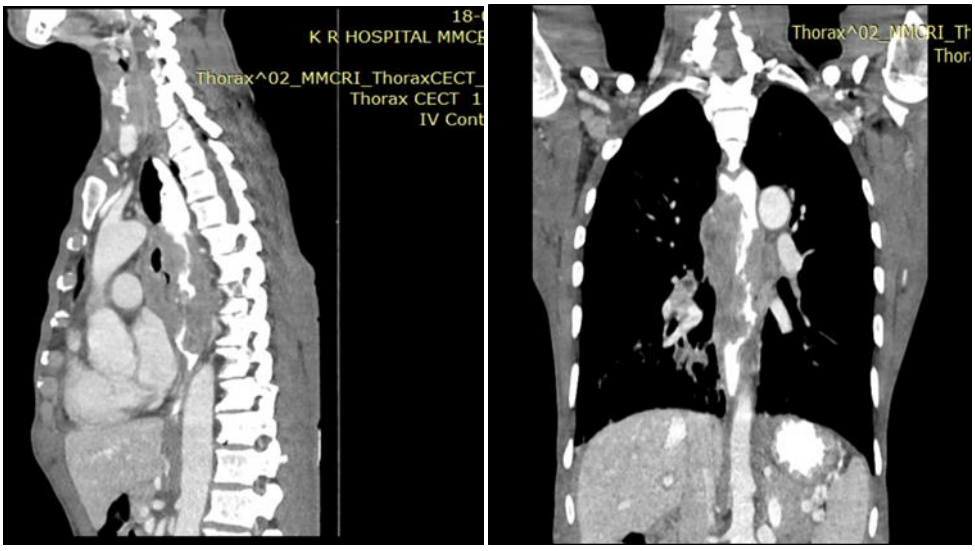
9.	T4 N0 M0	0	0%
10.	T4 N1 M0	0	0%
11.	T4 N2 M0	0	0%
12.	T4 N3 M0	0	0%

Representative images

CASE 1: A 60-year-old male patient complaining of dysphagia, pain in throat, weightloss, hematemesis and hoarseness of voice.



(A)



(B) **(C)**

CECT a) Axial b) Coronal and C) Sagittal images of 60-year-old male patient demonstrates oesophageal carcinoma with irregular asymmetrical wall thickening and heterogeneous wall attenuation involving mid 1/3rd and lower 1/3rd of oesophagus for length of approx. 10 cm with maximum wall thickness of 17mm causing significant luminal narrowing. The lesion is noted encasing lower trachea, carina, left main bronchus, infiltrating right main bronchus Lesion shows significant pre contrast enhancement of 25-40 HU and post contrast enhancement of 65-70 HU. Significant para tracheal, sub-carinal, para-esophageal and para-aortic lymphadenopathy noted. MDCT stage T4N3M0 -Stage III. HPE- Squamous cell carcinoma.

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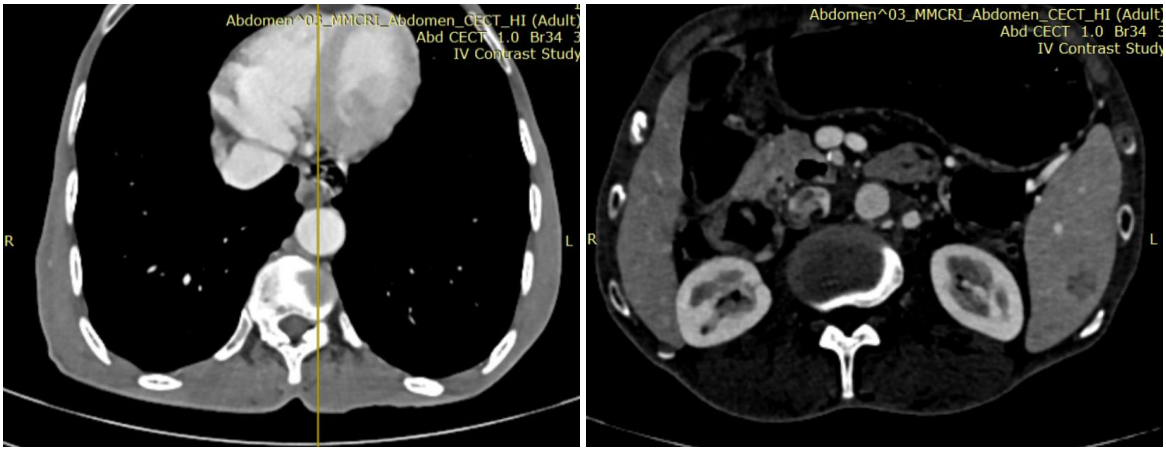
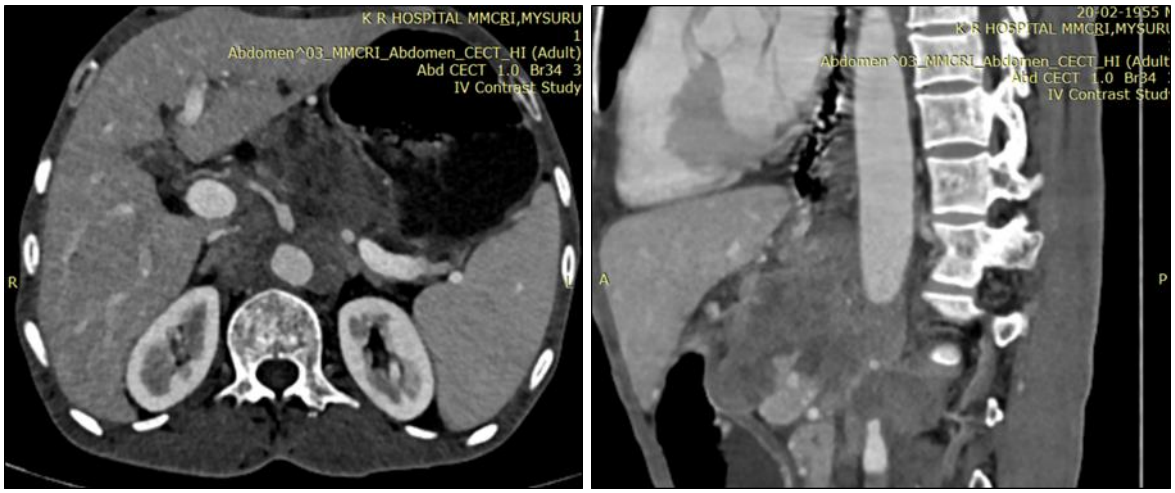
Case 2: A 65-year-old male patient complained of dysphagia, pain in the throat, weight loss, hematemesis and hoarseness of voice.



(A) **(B)**



(C) **(D)**

CECT A), B) & C) Axial and D) Sagittal images of 65-year-old male patient demonstrate oesophageal carcinoma with Irregular asymmetric heterogeneously enhancing focal wall thickening in the postero-lateral wall of mid oesophagus with a maximum thickness of 8.8 mm for a length of 3.3cm extending from the upper border of T6 to lower border of T7 vertebra. The lesion is noted to maintain fat planes with surrounding structures. The lesion shows significant pre-contrast enhancement of 30-40 HU and post-contrast enhancement of 50-60 HU. Metastatic lymphadenopathy was noted in pre-para-aortic region encasing coeliac trunk, SMA, bilateral renal arteries, and left renal vein. Spleen measures 13.5 cm, enlarged. Ill-defined heterogeneously enhancing hypodense area measuring 1.4 x 1.2 x 1.2 cm noted in lower pole of spleen-splenic metastases. MDCT stage T2N3M1-Stage IV. HPE-Squamous cell carcinoma.

Case 3: A 65-year-old female patient complaining of dysphagia, pain in the throat, weight loss, hematemesis and hoarseness of voice.

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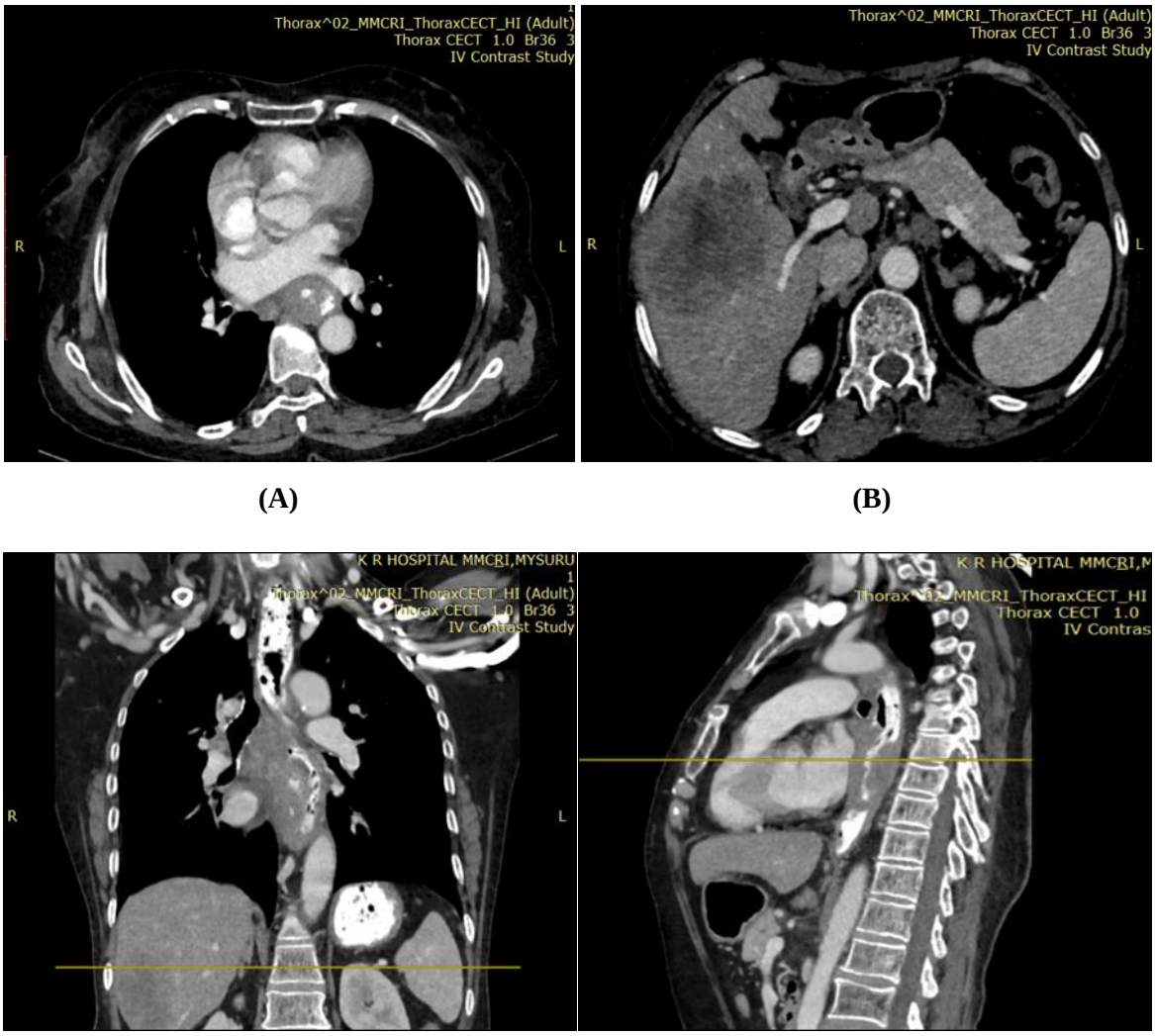

(A) **(B)**

(C) **(D)**

CECT A) & B) Axial C) Sagittal and D) Coronal images of 65-year-old female patient demonstrate oesophageal carcinoma with Irregular asymmetric circumferential wall thickening noted involving mid thoracic esophagus for a length of 5.9 cm and maximum thickness of 15 mm. The lesion is noted to cause significant luminal narrowing and proximal pooling of oral contrast; however, the distal passage of oral contrast was noted. The lesion shows significant pre-contrast enhancement of 30-45 HU and post-contrast enhancement of 50-55 HU. Multiple heterogeneously enhancing enlarged subcarinal, paraoesophageal and aortopulmonary lymph nodes noted. Fairly well-defined heterogeneously enhancing lesion with central non-enhancing area (s/o necrosis) noted in segments V and VI of liver measuring 7.6 x 6.6 x 7 cm. -liver metastasis. MDCT stage T2N2M1-Stage IV. HPE-Squamous cell carcinoma.

Case 4: A 43-year-old male patient complaining of dysphagia, pain in the throat, weight loss, hematemesis and hoarseness of voice.

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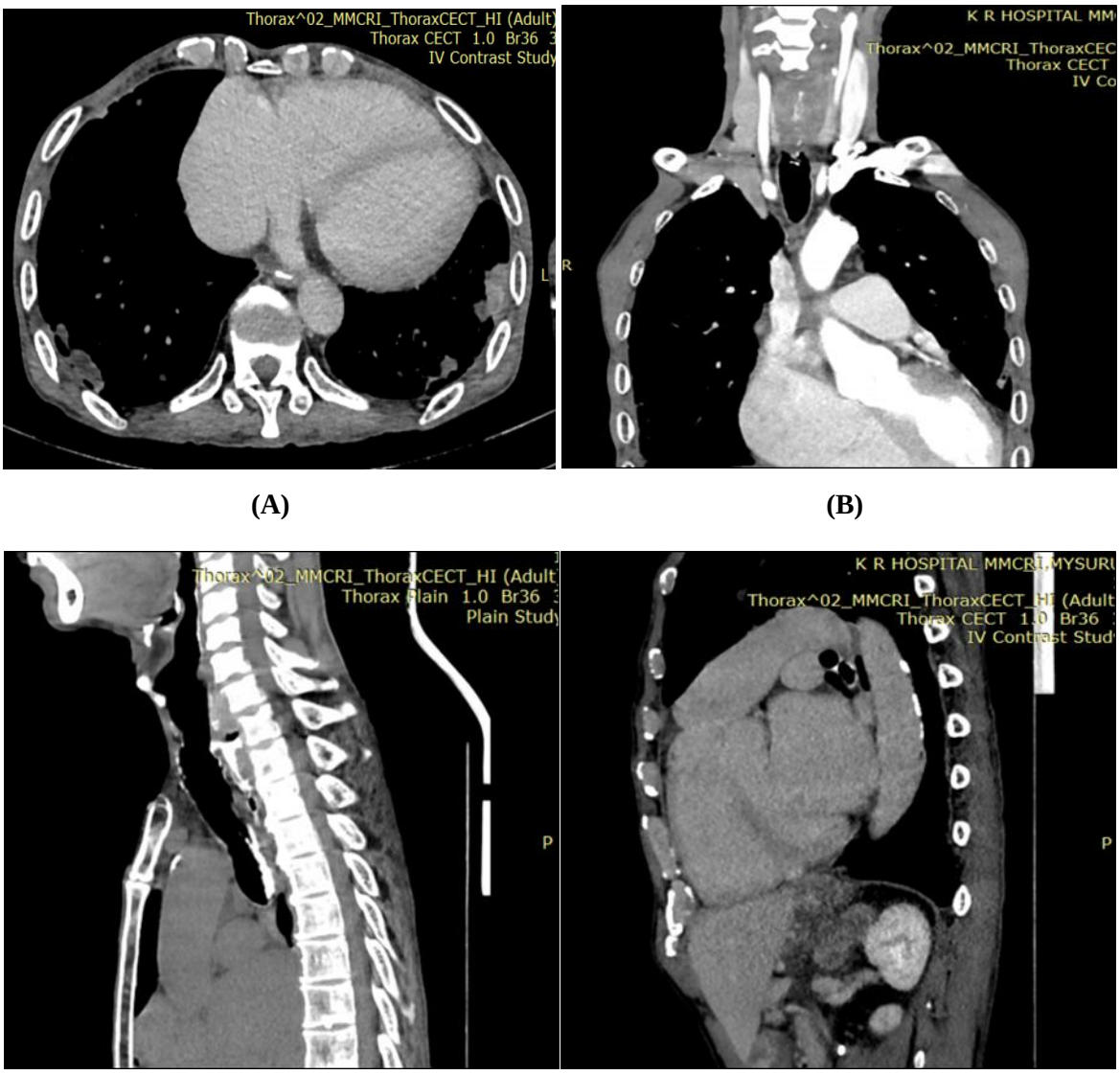

(A) **(B)**

(C) **(D)**

CECT A) Coronal B) Axial C) & D) Sagittal images of a 43-year-old male patient demonstrate oesophageal carcinoma with diffuse circumferential heterogeneously enhancing wall thickening noted involving the cervical and upper thoracic esophagus for a length of approx. 3.5cm with a maximum thickness of 12mm causing luminal narrowing, however the distal passage of oral contrast was noted. The lesion shows significant pre contrast enhancement of 25-45 HU and post contrast enhancement of 50-60 HU. The lesion (C) is noted infiltrating the posterior tracheal membrane and showing a fistulous tract at the level of T1 vertebra level with extravasation of oral contrast into the trachea and bronchi. Multiple enhancing lymph nodes noted in bilateral paratracheal, prevascular, subcarinal and aortopulmonary regions noted. Multiple well-defined subcentimetric nodular lesions of varying sizes were noted randomly distributed in bilateral lung parenchyma with branches of the pulmonary artery leading to the lesions (s/o feeding vessel sign)-pulmonary metastasis. Bulky left adrenal gland (2.5 x 1.5cm) showing heterogeneously enhancing exophytic soft tissue density lesion measuring 1.6 x 1.5 cm with a peripheral speck of calcification within-adrenal metastasis. MDCT stage T2N3M1-Stage IV. HPE-Squamous cell carcinoma.

Case 10: A 53-year-old male patient complaining of dysphagia, pain in the throat, weight loss, hematemesis and hoarseness of voice.

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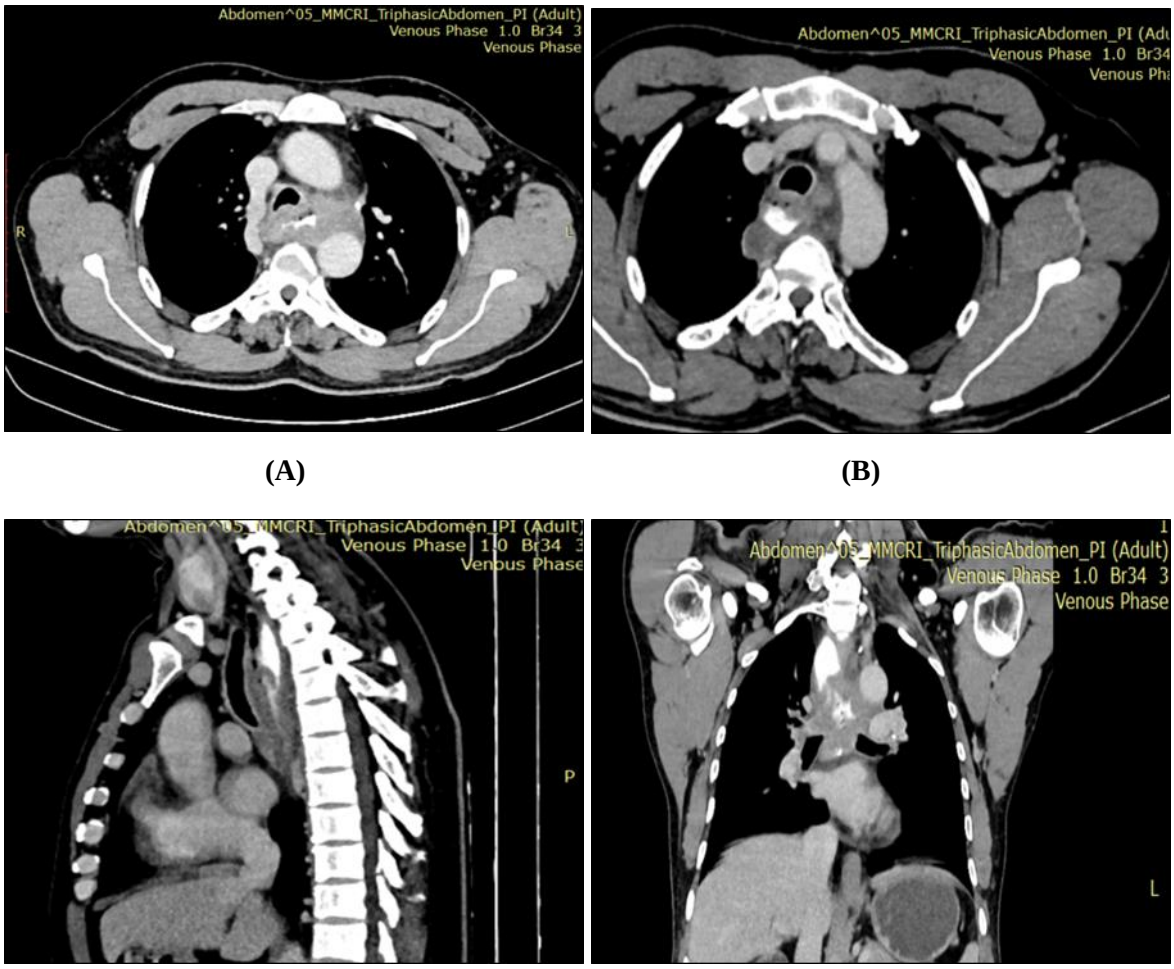

CECT A) & B) Axial C) Sagittal and D) Coronal images of 53-year-old male patient demonstrate oesophageal carcinoma with Diffuse circumferential heterogeneously enhancing wall thickening noted involving upper & mid thoracic esophagus for a length of ~ 8.5 cms with a maximum thickness of ~ 11 mm. significant luminal narrowing noted. However distal passage of contrast was noted. The lesion shows significant pre-contrast enhancement of 30-45 HU and post-contrast enhancement of 50-55 HU. The lesion is abutting the trachea and right & left main bronchus and arch of the aorta with arc of contact $>90^0$ and descending thoracic aorta with an arc of contact $<90^0$. Multiple heterogeneously enhancing lymph nodes were noted in right para esophageal and paratracheal stations. MDCT stage T3N2M0-Stage III. HPE-Squamous cell carcinoma.

Discussion

In the present study, on CT scan the length of the growth were as follows: ≤3 cm (2.6%), 3.1-6 cm (50%), 6.1-8 cm (17.9%) and >8 cm (29.5%). In the study by Huang *et al*. [7] on 1077 patients with thoracic esophageal carcinoma, the length of the tumor was as follows: ≤2 cm (9.9%), 2.1-4 cm (45.2%), 4.1-6 cm (32.4%), 6.1-8 cm (9.7%), >8 cm (2.8%). In another study by Yendamuri *et al*. [8] on 209 patients with esophageal carcinoma, tumor length was ≤3 cm in 57.9% and >3 cm in 42.1% of the cases.

Pretreatment staging of carcinoma oesophagus by MDCT is essential to determine the depth of esophageal wall penetration, the status of regional lymph node involvement, and the presence or absence of distant metastases so that patients can be guided to the appropriate treatment options and provided with prognostic information.

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Out of the total 78 patients diagnosed with carcinoma esophagus, 24 (30.1%) patients were staged under group stage IV. 23 patients (29.9%) were staged under group II. 27 patients (34.6%) were staged under group III.

Overall maximum patients (n=27, 34.6%) were staged under group stage III. The least number of patients (1.3%, n=1) had a group stage I on MDCT.

The overall sensitivity of MDCT in determining T1/2, T3 and T4 stages was 58.3%, 85.7%, 0% respectively. The overall specificity of MDCT in determining T1/2, T3 and T4 stages was 93.75%, 43% and 100% respectively.

Overall, out 32 cases, 22 cases showed identical 'T' stage on MDCT compared with histopathology and 10 cases showed different 'T' stage giving an overall accuracy of MDCT for T-staging of 69.65%.

In a study by Mehul S Pateliya *et al.* [9] on 100 cases of carcinoma oesophagus 17 patients (56.7%) had stage III disease, 12 (40%) had stage IV disease and only 1 patient (3.3%) had stage I disease. Thompson *et al.* [10] used TNM classification to stage 76 patients. 6 patients had stage I disease (7.6%), 6 had stage II (7.8%), and 37 had stage III (48.6%) disease. Moss *et al.* [11] out of 52 patients studied on CT found that no patient had stage I disease. 7 had stage II (13.4%), 33 had stage III (63.4%) and 12 had stage IV disease (23%).

Out of the 78 patients in our study 42.3% (n=33) were categorized as T3 stage followed by 41% (n=32) patients as T1 & T2 stage and 16.7% patients (n=13) as T4 stage. In a study conducted by Parveen Chandna *et al.* [12] on 25 patients of carcinoma oesophagus most of the patients (56%) were categorized under T3 stage followed by (36%) under T1 and T2 stages and only (8%) under T4 stage. Out of the 78 patients diagnosed on endoscopic histopathology as carcinoma oesophagus which were included in our study, only 32 patients underwent surgery. Hence post-operative histopathological analysis was done only for 32 patients and compared with CT findings. Out of the 32 patients operated, 26 patients had identical T stage and 6 patients had different T stage with overall accuracy of MDCT in T staging being 81.25%. The sensitivity, specificity, PPV and NPV of MDCT in determining T3 stage was 61.53%, 100%,100% and 79.16% respectively. The sensitivity, specificity, PPV and NPV of MDCT in determining T1 & T2 stage compared to post-operative results was 100%, 61.53%,79.16% and 100% respectively. In a study conducted by Mehul S Pateliya *et al.* [9] on 100 cases of carcinoma oesophagus out of 100 patients 54 patients had undergone operative intervention, hence operative and pathological staging for T stage was done for 54 patients. CT scan cannot reliably delineate the individual layers of the esophageal wall and thus cannot differentiate T1 from T2 neoplasm. Microscopic infiltration of the periesophageal fat (T3) can be present but not evident on CT scan. When the macroscopic invasion of mediastinal fat is present, CT scan demonstrates abnormal soft tissue density that is often ill-defined. Although tumor infiltration into the periesophageal fat (T3) adversely affects prognosis, en bloc resection of tumor as an attempted cure is not precluded. Tumor infiltration into an adjacent structure (T4) is critical for patient management; direct invasion of aorta and tracheobronchial tree precludes surgical resection. Out of operated 54 patients 45 patients had identical CT T stage with pathological and operative T stage showing an accuracy of CT scan of around 83.33 % in the Mehul S Pateliya *et al.* [9] study. In a study conducted by Sumithra *et al.* [1] out of 37 patients, 26 were operated and in those 26 patients, 19 patients showed identical T stage and 7 patients showed different T stage and the overall accuracy of MDCT was 73% in determining T stage.

In our study lymph nodes with short axis measurements greater than 1 cm was considered a predictor of metastatic adenopathies. Out of the 78 patients in our study 42.3% (n=33) were categorized as N2 stage followed by 28.2% (n=22) patients as N0 stage, 16.7% patients (n= 13) as N1 stage and 12.8% patients (n=10) as N3 stage. Out of the 32 patients operated on, 20 patients had identical N stage and 12 patients had different N stage with an overall accuracy of MDCT in T staging being 77%. The overall sensitivity of MDCT in determining N0, N1,

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N2 and N3 stages was 66.65%, 92.85%, 50%, and 27% respectively. The overall specificity of MDCT in determining N0, N1, N2 and N3 stages was 100%, 64%, 82.5% and 100% respectively.

Overall, out of 32 cases, 20 cases showed identical 'N' stage on MDCT compared with histopathology and 12 cases showed different 'N' stage giving an overall accuracy of MDCT for T-staging of 77% In a study conducted by Mehul S Pateliya *et al*. [9] on 100 cases of carcinoma oesophagus out of 54 patients operated lymph node stations were confirmed operatively and lymph nodes along with resected mass were sent for pathological confirmation. Out of 54 patients 44 patients had the same lymph node metastasis as diagnosed on CT scan showing that CT scan accuracy for N stage around is 81.48%. Large lymph nodes may also result from inflammatory disease leading to false positive results of CT scan. Microscopic invasion of normal size lymph nodes, also a common manifestation of esophageal carcinoma, is another factor limiting CT scan accuracy. In a study conducted by Sumithra *et al*. [1] out of 37 patients, 26 were operated and in those 26 patients, 21 patients showed identical N stage and 5 patients showed different N stage and the overall accuracy of MDCT was 80.7% in determining N stage.

Conclusion

MDCT provides significant and valuable information regarding the oesophageal wall thickness, site involved, the eccentricity of the growth, the approximate length of the tumor, dilatation of the esophagus just proximal to the growth, oesophageal luminal narrowing, peri-oesophageal soft tissue or fat stranding, local invasion to Aorta, pericardium and tracheobronchial tree. CT also provided detailed information about the significant lymphadenopathy pattern in patients with oesophageal carcinoma including both regional and non-regional lymphadenopathy. CT also guided in determining metastases to distant organs including Liver, Lungs, Bone, Adrenals, Kidneys, Spleen, Brain, etc.

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