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Original Research Article

Diagnosis and staging of lung carcinoma with CT scan and its histopathological correlation

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ABSTRACT

Background: Lung cancer is the most common cancer worldwide. Hence, timely diagnosis and accurate staging of the carcinoma is critical for the treatment and prognosis. So, this study was performed to evaluate the role of CT scan in diagnosis and staging of lung cancer.
Methods: This was a prospective and observational study carried out over one and half years at a tertiary care hospital. The patients found to have abnormalities on chest X-ray suggestive of carcinoma were included in the study. Pre and post contrast CT scans were performed. Individual patient biopsies were done for histopathological staging.
Results: Most patients belonged to 41-50 years age group with male preponderance (81.33%). Habit of smoking was prevalent among the lung cancer patients. Almost all masses (92%) showed heterogeneous contrast enhancement on CT. Additionally, there were calcifications, cavitation, hilar enlargement, pleural invasion, mediastinal lymphadenopathy and contiguous bone involvement. Adenocarcinoma was the most common (46.66%) form of cancer followed by squamous cell carcinoma (42.66%). For histopathological diagnosis, majority of patients (73.33%) were diagnosed using CT guided biopsy. In the remaining patients, USG guided biopsy or fibreoptic bronchoscopy were performed. The most common lobe affected by bronchogenic carcinoma was right upper lobe. The most common site of metastasis was pleura (22.66%) followed by bone (17.33%). Majority of the patients (41.33%) presented with TNM stage IV.
Conclusions: CT scan as a modality for detection and staging of bronchogenic carcinoma is superior to chest radiograph. CT guided FNAC has a high success rate in evaluation of lung carcinoma.

Keywords: Bronchogenic carcinoma, CT scan, CT guided biopsy, Histopathology, Tumor staging

INTRODUCTION

Lung carcinomas are a group of tumors that arise from any part of trachea, bronchi, bronchioles or the pulmonary parenchyma and can be derived from the cells of epithelium, mesenchyme and neural origin. Thus, it is a heterogenous entity both in the variety of cell type and in the biological behaviour of any particular cell type. Bronchogenic carcinoma is the most common cause of cancer-related death in men and second most common in women, worldwide.[1] It has been estimated that approximately 85% of lung cancers can be attributed to tobacco smoking.[2]

Imaging studies play a key role in the detection, staging and post-treatment follow up of patients with bronchogenic carcinoma. The strongest prognostic factor for survival in lung cancer cases is respectability of the tumor. Thus, accurate staging of the bronchogenic carcinoma is essential as the choice of treatment options

and patient prognosis are directly related to the stage at presentation. Computed tomography (CT) scan is the standard imaging modality used for the evaluation of bronchogenic carcinoma. Accordingly, this study was carried out with an aim to evaluate and correlate various radiological CT findings with histopathological diagnosis and for proper staging of bronchogenic carcinoma based on the revised international system classification scheme - T (primary tumor), N (nodal involvement) and M (metastatic disease) staging. Also, the diagnostic accuracy and limitations of CT and transthoracic percutaneous fine needle aspiration cytology (FNAC) in planning the treatment of bronchogenic carcinoma is also highlighted.

METHODS

This was a prospective and observational study carried out for duration of 1 and half years in the Department of Radio diagnosis of tertiary care hospital and medical college, Surat. The study was commenced after approval from institutional ethical committee.

The criteria for selection of patients were

- Discovery of an abnormality on the chest radiograph of a patient with no symptoms. (Health check-up programme)
- Pneumonia

    a. Pneumonia not completely resolving with antibiotics
    b. Associated with volume loss and absence of air bronchograms.

- Patient with normal chest X-ray, but positive sputum cytology or extra-thoracic phenomenon that could be caused by bronchogenic carcinoma
- In cases of opaque hemithorax to rule out an underlying carcinoma
- Bronchus 'cut off' with distal collapse consolidation seen on chest X-ray
- For further characterization of solitary pulmonary nodule on chest X-ray.

The patients were randomly selected for the study procedure based on the inclusion criteria. The data regarding the demographic details of the patient, chief complaints, relevant medical history was collected. General and systemic examination was performed in every patient. All the data were recorded in a predesigned, pre-approved proforma. Among the radiological investigations, chest X-ray, ultrasonography (USG) of chest and CT scan were done in all the patients. 5 and 10 mm contiguous computed tomographic sections of chest and upper abdomen were taken from lung apices to the level of adrenals. Both pre and post contrast scans were done.

All the patients were followed for their histopathological diagnosis. Comparison between probable histopathological diagnosis on radiological appearances and final laboratory histopathological diagnosis was done. For histopathological diagnosis, individual methods of biopsy, namely Ultrasound guided FNAC, CT guided biopsy and fibreoptic bronchoscopy, were performed. Patients were further followed up for treatment, but as most of them presented with extensive disease, they were lost to follow up.

RESULTS

In this study, 75 patients were enrolled based on the inclusion criteria. The peak age prevalence of the patients of Bronchogenic carcinoma was 41 - 50 years. Table 1 shows the prevalence of subtype of bronchogenic carcinoma in relation to the age of the patient. Out of 75 patients, 61 were male and 14 were female. Thus, incidence of Bronchogenic carcinoma was more in males (81.33%) as compared to females (18.66%).

Table 1: Histological cell type of bronchogenic carcinoma in relation to age.

Type of tumor	Range (years)	Mean age (years)
Squamous cell carcinoma	30 - 65	47
Adenocarcinoma	50 - 85	67
Small cell carcinoma	60 - 70	65
Pulmonoblastoma	<30	15
Bronchoalveolar carcinoma	30 - 50	40

The habit of smoking was observed in male patients. All smokers were smoking bidies /cigarettes. Smoking index was calculated. All of them had smoking index above 300. All males were smokers whereas only one female was smoker. There was high prevalence of bronchogenic carcinoma in smokers. 82.66% of patients in the study were chronic smokers. Hence this study proves that there is high association between smoking and occurrence of bronchogenic carcinoma.

In the present study, cough with expectoration (41.33%) was found to be the most frequent symptom in patients with lung carcinoma followed by dyspnoea on exertion (32%) and chest pain (28%). Constitutional symptoms were also equally common. Weight loss was noted in 12% of patients, haemoptysis in 6.66%, and hoarseness of voice in 4%. While convulsion (1.33%) and dysphagia (1.33%) were very rare symptoms which occurred in advance stages with metastasis. Metastatic complications in the form of paraplegia secondary to brain metastasis and bone pain were seen in 2.66% of cases, each. Most of the patients had more than one complaint.

In present study, non-small cell lung cancer subtype adenocarcinoma (46.66%, n = 36) occurred most frequently followed by squamous cell carcinoma

(42.66%, n = 32). There was only one case of small cell carcinoma. The other rare tumors like pulmonoblastoma, broncho alveolar carcinoma and others constituted around 10% of cases.

Table 2: CT findings in primary bronchogenic carcinoma.

Findings	No. of cases	% of cases
Pattern of enhancement	69	92
Calcification	24	32
Cavitation	07	9.33
Hilar enlargement	13	17.33
Distal collapse	35	46.66
Pleural effusion	16	21.33
Mediastinal lymphadenopathy	16	21.33
Mediastinal Invasion	24	32
Rib, chest wall and pleural invasion	17	22.66
SVC compression	04	5.33
Vertebral Invasion	02	2.66

From the Table 2 it is evident that almost all masses (92%) showed heterogeneous contrast enhancement on CT scan. Calcification was present in 32% of cases, while cavitation in 9.33% of cases. 17.33% of cases presented with hilar enlargement. Distal collapse was seen in 46.66% of cases. Pleural effusion was associated with 15.38% of cases. Mediastinal lymphadenopathy was noted in 21.33% of cases. 32% had mediastinal invasion. SVC compression was noted in 5.33% of cases. Ribs, chest wall and pleural invasion was seen in 22.66% of cases, while vertebral invasion in 2.66% of cases. Figure 1-4 shows X-ray and CT findings of one case with left lower lobe carcinoma.

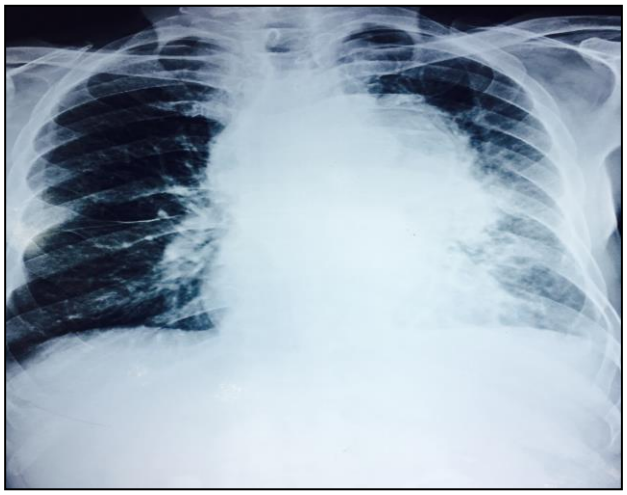

Figure 1: Large soft tissue opacity lesion in left hilar/perihilar region with broad base towards mediastinum. Rest of lung fields appear normal.

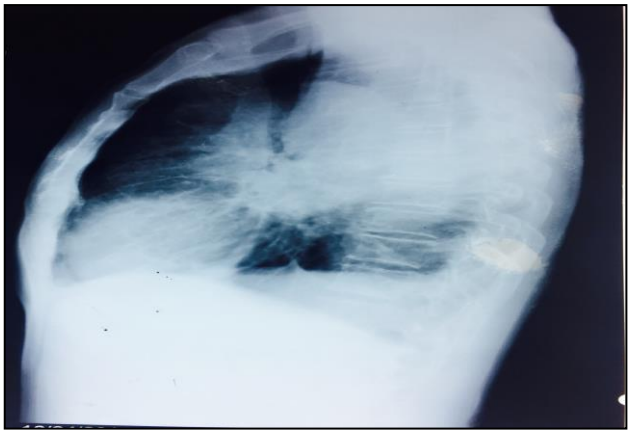

Figure 2: The same lesion on lateral X-ray extending and surrounding the hilum and main stem bronchus.

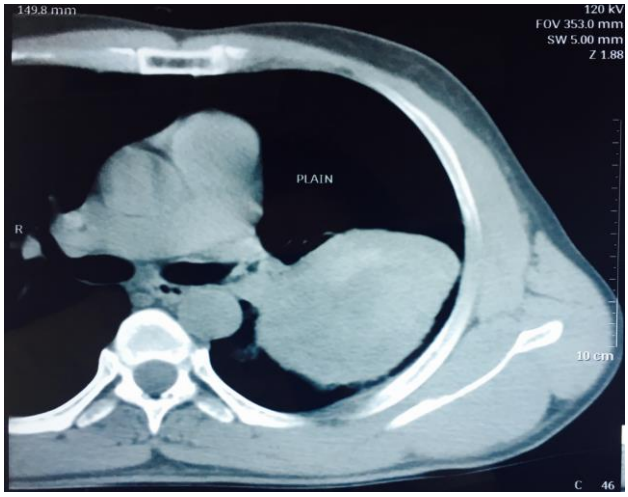

Figure 3: Large soft tissue density lesion in superior segment of left lung lower lobe reaching upto hilum and extending into left main stem brouchus.

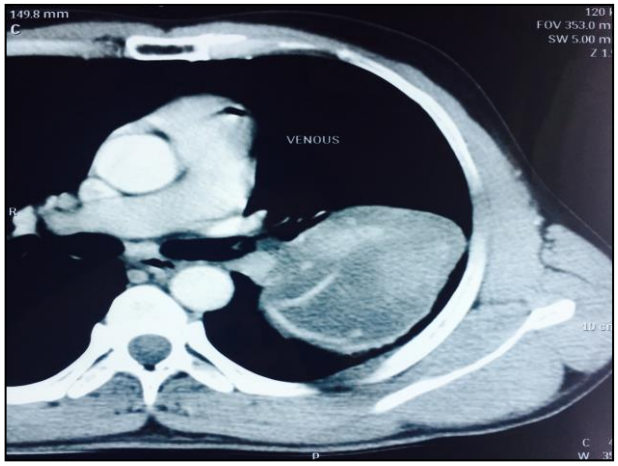

Figure 4: The mass shows heterogeneous enhancement with few traversing vessels are seen and causing narrowing of left main stem bronchus.

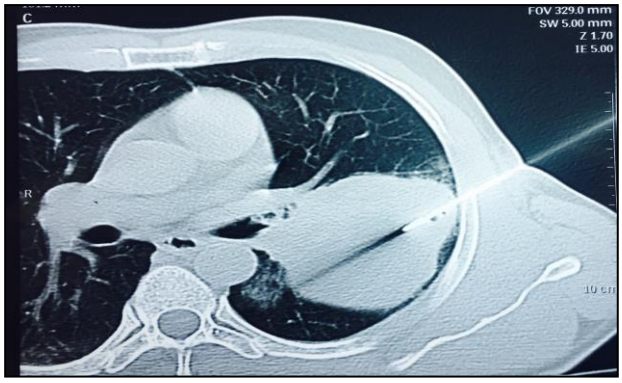

Figure 5: Biopsy needle is seen within the left lung mass.

Table 3 shows the radiographic pattern in various histological subtypes of lung carcinoma. Squamous cell carcinoma presented as pulmonary lesion < 4 cm of size in 4 cases. Among the cases of squamous cell carcinoma, 15.62% were hilar, 12.5% were < 4 cm in size. While apical mass noted in 4 (12.5%) and pneumonitis, collapse or consolidation in 9 (28.12%) of cases. 12 (37.5%) cases presented with mediastinal involvement and 10 (31.25%) patients with chest wall lesion, while pleural effusion was noted in 8 (25%) cases of squamous cell carcinoma. Among the cases of adenocarcinoma 8 (22.85%) were hilar, 6 (17.14%) were < 4 cm in size, 3 (8.5%) were with apical mass, 3 (8.5%) with pneumonitis, 12 (34.28%) with mediastinal involvement and 7 (20%) each with chest wall lesion and pleural effusion.

Table 3: Radiographic pattern of lung cancer compared with histological type.

Radiographic Finding	Squamous cell carcinoma	Adeno carcinoma	Broncho-alveolar carcinoma	Non-diffentiated carcinoma	Neuro-endocrine tumor
Hilar, perihilar mass or prominence	5	8	-	-	-
Pulmonary lesion < 4 cm	4	6	2	-	-
Apical mass	4	3	-	-	-
Pneumonitis collapse or consolidation	9	3	1	-	-
Mediastinal involvement	12	12	-	1	-
Chest wall lesion	10	7	-	1	-
Pleural effusion	8	7	-	1	-

Table 4: Sites of origin of lung cancer.

Histopathological diagnosis	Upper lobe		Middle lobe		Lower lobe		Hilum	
	No. of cases	% of cases	No. of cases	% of cases	No. of cases	% of cases	No. of cases	% of cases
Squamous cell carcinoma	18	24	02	2.66	05	6.66	07	9.33
Adenocarcinoma	20	26.66	06	08	04	5.33	04	5.33
Small cell carcinoma	-	-	01	1.33	-	-	-	-
Broncho-alveolar carcinoma	01	1.33	-	-	01	1.33	-	-
Neuro endocrine carcinoma	-	-	-	-	-	-	01	1.33
Poorly differentiated carcinoma	03	04	-	-	-	-	-	-

For histopathological diagnosis, majority of patients (73.33%, n = 55) were diagnosed using CT guided biopsy (Figure 5). USG guided biopsy was performed in 12 (16%) cases and fibreoptic bronchoscopy in 08 (10.66%) cases. The most common complication of CT guided FNAC was pneumothorax which occurred in 2 patients.

The most common lobe affected by bronchogenic carcinoma was right upper lobe. The ratio of involvement of right lung to left was 39:34. Upper lobe was affected more frequently (n = 42) as compared to middle and lower lobes. Table 4 shows the sites of origin of different histopathological subtypes of lung cancer in all the patients. Adenocarcinoma was most prevalent cell type in upper lobe and middle lobe carcinomas; while squamous cell carcinoma was most common in lower lobe and as hilar mass.

Table 5 shows the lymph node involvement in various histological subtypes. A size criterion of 10 mm in

smallest diameter was considered as suggestive of lymph node involvement. Among the cases of squamous cell carcinoma, 6 patients were in N3 stage and 1 in N2 stage, while in adenocarcinoma cases, 6 patients were in N3 stage, 3 in N2 stage and 2 in N1 stage. Table 6 shows the distribution of metastasis at the time of diagnosis in patients with bronchogenic carcinoma.

Table 5: Histopathological cell type of bronchogenic carcinoma in relation to lymph node involvement.

Type	Peribronchial/ hilar	Subcarinal/ Ipsilateral mediastinal	Contralateral mediastinal/ supraclavicular
Squamous cell carcinoma	07	07	06
Adenocarcinoma	10	09	06
Non-differentiated carcinoma	-	01	-

Table 6: Distribution of metastasis in bronchogenic carcinoma.

Site	No. of cases	% of cases
Lungs	05	6.66
Pleura	17	22.66
Liver	09	12
Adrenal	06	8
Brain	06	8
Bone	13	17.33
Spleen	02	2.66
GIT	01	1.33

Table 7: Non-small cell carcinoma: extension of disease at the time of presentation.

Stage	No. of cases	% of cases
I	11	14.66
II	18	24
III A	05	6.66
III B	08	10.66
IV	31	41.33

The most common site of metastasis was pleura (22.66%) followed by bone (17.33%) and opposite lung (6.66%). Among the contiguous bone metastasis, intraspinal extension was most commonly found (n =5) followed by sternum, ribs and vertebra. Table 7 gives the TNM staging of the non-small cell lung cancer at the time of presentation. Majority of the patients (41.33%) presented with stage IV advanced disease and metastasis. One case was diagnosed in TxNoMo stage. In our study, only one case of small cell carcinoma had been reported in limited stage (IA).

DISCUSSION

The incidence of lung cancer is continuously increasing globally in both men and women. Availability of newer imaging techniques has made it possible to diagnose bronchogenic carcinoma in the earlier stages and thus improves the prognosis of the patients. This study was carried out with an aim to evaluate the role of one such imaging technique i.e. CT scan in the diagnosis and staging of lung cancer. In present study, the most common age group affected with lung carcinoma was 41-50 years of age. There was a predominance of male patients. This may be due to higher incidence of smoking in male population. In the present study, high degree of association was found between smoking and incidence of lung cancer. 82.66% of patients were chronic smokers. Smoking, especially of cigarettes, has been clearly established in the literature as a major risk factor for the development of lung cancer.[3]

Cough with expectoration was found to be the most common symptom followed by dyspnoea on exertion and chest pain. These are well documented in various textbooks as the most common signs and symptoms which suggest lung cancer. These are divided into respiratory symptoms such as coughing, hemoptysis, dyspnea; systemic symptoms such as weight loss, fever, clubbing and symptoms due to the pressure on adjacent structures such as chest pain and bone pain.[4] In the present study, adenocarcinoma (46.66%) occurred most frequently followed by squamous cell carcinoma (42.66%). This is in contrast to some of the previous Indian studies which showed squamous cell carcinoma to be the most frequent subtype; but similar to the findings of some recent studies in India which shows a changing pattern of lung carcinoma from squamous cell carcinoma to adenocarcinoma.[5-8] This change may be due to changes in smoking habits. Most of the masses (92%) showed heterogeneous contrast enhancement on CT scan. In addition, there was calcification, cavitation, hilar enlargement, distal collapse, pleural effusion, mediastinal lymphadenopathy, mediastinal invasion, SVC compression, ribs, chest wall and vertebral invasion. Atelectasis is more commonly caused by endobronchial carcinoma and rarely by surrounding bulky lymph nodes. Because airway obstruction is usually complete, air cannot pass distally and air bronchogram is thus absent. This sign is virtually pathognomonic of an endobronchial obstructing lesion.

Woodring JH described that the radiographs are more specific than CT for tumor as a cause of atelectasis (96 versus 87%), but it is less sensitive than CT for tumor (89% versus 100%) resulting in missed tumor diagnosis.[9] In our study, out of 35 patients presenting with atelectasis, in 3 patients underlying tumor was not diagnosed on radiographs but all the patients were diagnosed as having distal atelectasis due to tumor on CT scan. White et al. demonstrated that endobronchial location and lower lobe predominance were the most common characteristics of overlooked lung cancer on CT scan.[10] Patz et al described that non-enhanced CT thorax through adrenal gland is sufficient for successful staging and contrast-enhanced CT (CECT) thorax did not substantially alter the tumor staging.[11] However, in this study CECT was done in majority of the patients to differentiate necrotic part of the tumor through which biopsy should be avoided and it was helpful in distinguishing central partially obstructing endobronchial mass from more distal collapsed or consolidated lung. In our study, 16 patients had pleural effusion but it was not possible to differentiate benign from malignant effusion from CT scan.

In present study, the most common presentation for chest wall invasion was loss of fat plane with the pleura. It is a sensitive criterion but not specific because contiguity of tumor with parietal pleura was found not to be equivalent with definite invasion of chest wall, even when associated with pleural thickening. Erosion of a rib is a highly specific but not sensitive criterion. Pennes et al described CT criteria for chest wall invasion and concluded that CT is not accurate in assessment as criteria are either highly sensitive and non-specific or vice versa.[12] Kuriyama et al found that lesions classified as T1 on two dimensional axial CT images were correctly reclassified as T2 (visceral pleural invasion) or T3 (parietal pleural involvement) on 3D images in 10-46 patients. The sensitivity of pleural puckering was high, but specificity was only 76% because it was not only seen with tumor invasion but also with reactive fibrotic changes.[13]

CT guided biopsy was done in majority of the patients. CT guided FNAC is especially useful when the peripheral lesion is not approachable by US, or if the lesion is adjacent to hilum, mediastinum, aorta or heart. In our study, we had done CT guided FNAC from the peripheral lesions as well as bulky mediastinal lymphadenopathy adjacent to vessels in selected patients. Singh JP et al. concluded that CT guided FNAC is highly sensitive and specific technique with good diagnostic accuracy and can be used safely as an outpatient procedure for the diagnosis of thoracic masses.[14]

Li et al, described diagnostic accuracy of CT guided biopsy as significantly less for small lesions as compared to large nodules but the complication rates for both are low.[15] Pneumothorax was the commonest complication in our study which occurred more with 18 gauge needles. However, none of the patients required a chest tube drain. Geragthy et al, described significant increase in rate of pneumothorax seen in patients older than 60 years. There was a significant increase in rate of pneumothorax with 18G compared with 19.[16] USG guided FNAC was done in pleurally based bronchogenic carcinoma as it is helpful in the form of short procedure time, especially helpful in less cooperative patients, in tumour exhibiting central necrosis. Fibreoptic bronchoscopy was done in central endobronchial mass, cavitating lesions or lesions that were immediately adjacent to heart or usually best approached first via the bronchoscope. Using flexible bronchoscope diagnostic accuracy is upto 95% for lesions visible through microscope; but the procedure is time consuming and more expensive. Laroche et al, described the role of CT thorax prior to bronchoscopy in the investigation of suspected lung carcinoma as it may provide staging, relation, road map, site of biopsy and other associated lesions or findings on CT may obviate the need for bronchoscopy.[17]

The most common lobe affected by lung cancer in our study was found to be right upper lobe. This is similar to the findings of Garland et al. which described the lobar distribution of bronchogenic carcinoma in 250 cases and found relative frequency of 3:2 in right versus left lung and upper versus lower lobe.[18]

Ipsilateralmediastinal lymph nodes were most commonly involved in all the subtypes of bronchogenic carcinoma. Quinn et al. reviewed the radiographic presentation in 345 cases. Mediastinal lymph nodes were seen in 62% small cell carcinoma, 36% adenocarcinoma, 32% large cell carcinoma and 26% squamous cell carcinomas.[19] Metastasis was most common in pleura followed by bone and opposite lung. Riihimaki M et al conducted a population-based survey and concluded that bone (39%) and respiratory system (22%) metastases were common in patients with adenocarcinoma andliver (35%) and nervous system (47%) metastases in patients with small cell lung cancer.[20]

There are certain limitations of CT scan when used for diagnosis and staging of lung cancer. The use of CT scan for detection of tumor invasion to adjacent structures such as pleura and chest wall is less specific and less sensitive. Also, it has low sensitivity and specificity for determination of nodal status based on the fact that enlarged lymph nodes may be hyperplastic rather than neoplastic and normal sized lymph nodes may contain neoplastic cells. Thus, CT can both understage as well as overstage bronchogenic carcinoma. Also, CT guided FNAC can be inconclusive because of low cell yield.

CONCLUSION

CT scan as a modality for the detection of bronchogenic carcinoma is superior to chest radiograph. Staging of T1 and T2 tumors is based almost exclusively on CT scanning. Major extra thoracic sites of metastasis such as

liver and adrenals are well studied using CT thorax with high accuracy. But the situation becomes more difficult with T3 and T4 tumors where the differentiation is critically important for determining the course of treatment. So, other modalities such as PET scanning, MDCT can be used to complement CT for further planning and intervention. Fusion imaging with PET or SPECT has a promising future for staging and intervention.

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