Role of Multidetector Computed Tomography (MDCT) in Evaluation of Lung Nodule with Histopathological Correlation

Jagmohan Gupta, Parul Gupta, Suresh Chandra Gupta, Amit Tak

Abstract

Background: Lung cancer is the most common and lethal cancer around the world. Computed tomography (CT) is an integral imaging technique for staging the lung cancer. Aim of this study was to correlate the multidetector CT (MDCT) findings of lung nodule with histopathological examination, as well as to assess the diagnostic accuracy of MDCT in evaluation of suspected lung nodule.

Methods: One hundred patients with clinical or radiological suspicion of lung nodule referred for CT scan of thorax were included in the study. Histopathological analysis was performed. The location of the lesion was analysed and nodules were classified. Fine needle aspiration cytology (FNAC) was done with spinal needle under all aseptic precautions. The results obtained by MDCT were analysed and compared with histopathological findings done by CT guided FNAC.

Results: Average age of patients was 65 years, 25 % were females and 75 % were males. Among all the patients 66 % of lesions were located in right side lung and 34 % of lesions were left in location. Of all, 2 % patients had lesions less than 3 cm, 11 % patients had lesion between 3-4 cm, 19 % patients had lesion between 4–5 cm, 26 % patients had lesion between 5-7 cm and 42 % patients had lesion greater than 7 cm. Many of these patients also presented with enlarged lymph nodes, most commonly mediastinal (73 %) followed by subcarinal (51 %), hilar (44 %) and supraclavicular (4 %) lymph nodes. The most common histological findings of lung nodules analysis were adenocarcinoma (41 %). Among the 100 patients 58 % had lesions located peripherally while 42 % had central lesions.

CT was a highly sensitive (95.45 %) and moderately specific (75 %) test and also had a high positive predictive value (96 %) to diagnose malignant lung nodule.

Conclusion: CT guided FNAC of lung nodule is a safe, minimal invasive procedure with a high diagnostic accuracy. The use of CT – guided FNAC in hilar and mediastinal nodules can avoid unnecessary exploratory surgery for staging and also diagnosis could be made with lesser cost.

Key words: MDCT; Fine needle aspiration cytology; Lung cancer; Sensitivity; Positive predictive value.

Introduction

Lung cancer is among the most common and lethal cancer around the world. It represents about 13 % of the new cancer cases and up to 28 % of the cancer deaths. Most lung cancers are directly attributed to smoking. Lung is also the most common site of metastatic involvement from other extra thoracic malignancies; 20 to 54 % of extra-thoracic malignancies have pulmonary
metastatic disease. A wide variety of imaging techniques are currently available for detection, diagnosis and management of lung cancer. Chest imaging is the primary modality for detection of lung nodules and masses. Computed tomography (CT) and positron emission tomography (PET) are most commonly used imaging modalities for further characterisation and to define extent of malignancy. Along with non-radiological modalities, CT is used for pre-treatment staging of the lung malignancies. Imaging is also required to assess the response to non-surgical treatment and for follow up in treated patients.

CT is more accurate for detection of a small lung nodule and it is a modality of choice for evaluation and classification of lung cancer. CT is an integral imaging technique for staging the lung cancer. Multidetector CT (MDCT) accurately stages the tumour due to the superior multiplanar reformatted images. Till now there is no state sponsored lung screening program in India. This is partly attributed to high prevalence of granulomatous disease (tuberculosis - TB) in India, in which imaging finding may mimic early cancers resulting in significant anxiety and consequently usage of more invasive tests to prove the nature of these nodules; and also due to lack of availability of sufficient imaging, pathology and surgical facilities.

The merits of CT in intrathoracic scanning are innumerable. The most important among them, is the ability to evaluate lung lesions on its own and to differentiate them in terms of benign and malignant with reasonably high degree of accuracy. With this background the present study was undertaken to establish the role of CT in comprehensive evaluation of lung neoplasia, especially in Indian set-up and to study the efficacy and safety of CT-guided biopsy.

Aim of this study was to correlate the MDCT findings of lung nodule with histopathological examination, as well as to assess the diagnostic accuracy of MDCT in evaluation of suspected lung nodule.

Methods

This was a hospital based observational study. One hundred patients with clinical or radiological suspicion of lung nodule referred for CT scan of thorax to the Department of Radio-Diagnosis, Mahatma Gandhi Medical College and Hospital, Jaipur (Rajasthan) were included in the study. Histopathological analysis was performed. Study was approved by Ethic committee of the Hospital.

Data was collected from all cases of suspected lung nodule in a specified form. X-ray was done by X-ray machine Allenger-500/800 MA and a contrast enhanced CT was performed with a 128 slice GE Optima 660 scan machine.

For CT evaluation, the standard protocol involved scanning the entire thorax from the lung apices to the costophrenic angles in supine position. Further thin sections were taken in the region of interest to eliminate partial volume averaging depending on the size of the lesion.

Both non-contrast and contrast enhanced scans were performed in most cases. Used contrast was non-ionic, water soluble, iohexol 350 mg I/mL. The dose of contrast was 1-2 mL/kg body weight administered by rapid intravenous bolus injection. Scanning began immediately after administration of the contrast injection.

The location of the lesion was analysed and nodules were classified. Fine needle aspiration cytology (FNAC) was done with Spinocan® spinal needle under all aseptic precautions. The lesion identified on CT and the site of entry was noted. Two to four mL of local anaesthesia was injected at the site after 2-3 min Spinocan® needle (18-20 inches) was used and introduced. The tip of the needle, identified within the lesion with the help of CT. FNAC was taken and both dry and wet slides were prepared and sent to the pathology department. The results obtained by MDCT were analysed and compared with histopathological findings done by CT guided FNAC.

Results

Among the 100 patients included in this study, the maximum age distribution was between the age group of 40-89 years with a mean age of 65 years. Gender-wise, 25 % of patients were females and 75 % were males. Most common presenting symptom was cough with expectoration (79 %), weight loss (63 %), dyspnoea (55 %),
chest pain (54 %), anorexia (39 %) and haemoptysis (36 %) followed by fever (16 %), hoarseness of voice (12 %) and dysphagia (1 %). The distribution of different test modalities is shown in Table 1. Among all the patients 66 % of lesions were located in right side lung and 34 % of lesions were left in location. Of all, 2 % patients had lesions less than 3 cm, 11 % patients had lesion between 3-4 cm, 19 % patients had lesion between 4-5 cm, 26 % patients had lesion between 5-7 cm and 42 % patients had lesion greater than 7 cm. Many of these patients also presented with enlarged lymph nodes, most commonly mediastinal (73 %) followed by subcarinal (51 %), hilar (44 %) and supraclavicular (4 %) lymph nodes.

### Table 1: Diagnostic methods and test results

<table>
<thead>
<tr>
<th>Diagnostic Method</th>
<th>Malignant</th>
<th>Benign</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Ray</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>CT-Scan</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>FNAC</td>
<td>88</td>
<td>12</td>
</tr>
</tbody>
</table>

*CT: computed tomography; FNAC: Fine needle aspiration cytology;*

Patients also presented with complications and mediastinal and nodal involvement of nodules as shown in Figure 1.

In this study the most common histological findings of lung nodules analysis were adenocarcinoma (41 %) (Figure 2) followed by others as shown in Table 2. Among the 100 patients 58 % had lesions located peripherally while 42 % had central lesions. Among the central lesions, 45.23 % were squamous cell carcinoma (n = 19), 19.04 % were adenocarcinoma as well as small cell carcinoma respectively (n = 8), 4.76 % cases were of undifferentiated large cell carcinoma and metastatic nodule, respectively (n = 2) while 7.14 % were benign nodules (n = 3). Among the peripherally situated lesions 56.89 % were adenocarcinoma (n = 33), 8.62 % were metastatic nodule (n = 5), 6.89 % ( n = 4) were squamous cell carcinoma and undifferentiated large cell carcinoma, 5.17 % were small cell carcinoma (n = 3), while 15.51 % of lesions were benign (n = 9). Histopathological findings related to gender are shown in Table 3.
In presented study, 31% of patients were non-smokers, and 69% were smokers. Histopathological findings related to smoking status is shown in Table 4.

Table 4: Histopathological findings related to smoking status

<table>
<thead>
<tr>
<th>Histopathological findings</th>
<th>Non-smokers</th>
<th>Smokers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenocarcinoma</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>Squamous cell carcinoma</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Small cell carcinoma</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Metastatic nodules</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Undifferentiated large cell carcinoma</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Benign lesions</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>69</td>
</tr>
</tbody>
</table>

The comparative evaluation of CT and CT guided FNAC for diagnosis of lung nodules is shown in Table 5.

Table 5: Comparison of computed tomography (CT) diagnosis with histopathological diagnosis of lung nodules

<table>
<thead>
<tr>
<th>Histopathological diagnosis for lung cancer</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT diagnosis for lung cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>84</td>
<td>3</td>
<td>87</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>9</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 6: Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of computed tomography (CT) to diagnose lung nodules

<table>
<thead>
<tr>
<th>Validity Test</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>95.45%</td>
</tr>
<tr>
<td>Specificity</td>
<td>75.00%</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>96.00%</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>69.00%</td>
</tr>
<tr>
<td>Accuracy</td>
<td>93.00%</td>
</tr>
</tbody>
</table>

CT was a highly sensitive (95.45%) and moderately specific (75%) test and also had a high positive predictive value (96%) to diagnose malignant lung nodule as shown in Table 6.

Discussion

Lung masses whether asymptomatic or presenting with various symptoms have always been challenging entities for both clinicians and radiologists. Many diagnostic modalities and various techniques and approaches have been put forward from time to time. MDCT in the present scenario opened a new horizon for evaluation of intrathoracic masses without any invasive procedure. The present study was undertaken to establish the role of CT and CT guided fine needle aspiration cytology in lung masses.

In this study mean age of the patients was in concordance with study by Gangopadhyay et al, Dharmaraj et al, Ahmed et al, Gupta et al, Indiranarayan et al, Saha et al, Singh et al, while it was contrary to study done by Mundal et al and Mukherjee et al. In the present study there were 75% male patients out of 100 patient. That result is similar to findings of Gangopadhyay et al, Gadodiya et al and Saha et al, while in some studies the preponderance is very high ie more than 80% were male patients. In this study 61% of males and 92% of females were smokers. High level of association between smoking and occurrence of lung nodules was observed. Similar findings were seen in study done by Meena et al, Narayan et al, where 71.36% and 65% patients were smokers, respectively. The most common presentation of patient was cough with expectoration. Some other symptom like anorexia, fever, haemoptysis, hoarseness of voice and dysphagia were also present in some patients but to a lesser extent. Similar findings were observed in studies by other researchers. Out of 100 patients with lung nodule - with X-ray 77%, with CT scan 87% and with FNAC 88% cases were reported malignant and rest were benign. Also, 66% of lung nodules were found in the right lung and only 34% were present in left lung. Similar findings were seen in study done by Ahmed et al (45% right, 31% left lung), Mundal et al (72% right, 52% left lung) and Saha et al. Fifty-eight percent of nodules had peripheral location while 42% were located centrally. This is in concordance with the study done by Adaikkalavanan et al, Biswas et al, Narayanswami et al. Maximum lung nodules in this study were more than 7 cm in size. This suggest that most of the lung nodules express symptoms in patient in their later stages of life, when the size of the lung nodule have already
been increased. Similar findings were found in literature. Patients with lung nodules also had various types of lymphadenopathy. Of all patients 73% patient had enlarged mediastinal lymph nodes, 51% had subcarinal and 44% had hilar lymph node involvement. There were similar findings seen in study done by Yadav et al. The amount of enhancement of 100 lung nodules were studied by measuring the CT numbers of both benign and malignant nodules on both pre contrast scan and post contrast scan showing maximum enhancement. There was no statistically significant difference between heterogeneity of contrast enhancement. In the present study contrast enhancement was only showed by malignant lesion that helps in identification of lesion easily. The most common histopathological subtype was adenocarcinoma which accounted for 41% cases. This is in concordance with studies done by Shad et al, Modi et al, Babu et al, Gangopadhyay et al that showed that there was an increasing trend in the incidence of adenoma, contrary to the studies done by Adaiikkalavan et al, Rawat et al, Saha et al, Ahmed et al, Narayan et al. In all these studies squamous cell carcinoma was the most predominant subtype. Adenocarcinoma was seen more at peripheral location (56.84%), than central (19.04%). Small cell carcinoma was also more in central location (9.04%) while large cell carcinoma was seen both in central (4.76%) and peripheral location (6.89%) equally. Similar findings were seen in the study done by Narayan et al. In this study there is evidence of strong association between smoking and occurrence of adenocarcinoma and squamous cell carcinoma. Similar results were obtained in study by Krishnamurthy et al, Arora et al and Meena et al. The present study showed that MDCT is highly sensitive (95.45%) and moderately specific (75%) and also has a high positive predictive value (0.96) in diagnosis of lung nodules accurately. In a study done by Mukherjee et al there was 97.7% sensitivity and 100% specificity for CT guided FNAC as a diagnostic procedure. Overall occurrence for cytological subtyping was 95%. Similarly in study done by Meena et al there was 96.23% sensitivity and 87.50% specificity for CT as a diagnostic procedure.

**Conclusion**

CT is a highly sensitive and moderately specific diagnostic modality and also has a high positive predictive value to diagnose lung nodules accurately. In addition to morphological evaluation, CT provides information about staging of the disease. CT guided FNAC of lung nodule is a safe, minimal invasive procedure with a high diagnostic accuracy. The use of CT – guided FNAC in hilar and mediastinal nodules can avoid unnecessary exploratory surgery for staging and also diagnosis is made with lesser cost. It provides very early diagnosis and exact sub classification of various lung nodules on the basis of histopathology. Benign lesions like tuberculosis, lung cyst, pneumonitis etc can also be diagnosed with certainty by this technique. The shortcomings in the diagnosis can be prevented by proper clinical and radiological correlation.

**Acknowledgements**

None.

**Conflict of interest**

None.

**References**

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