A STUDY OF IMAGING SIGNS OF THORACIC LESIONS AND COMPARISON OF IMAGING DIAGNOSIS BY COMPUTED TOMOGRAPHY (CT) WITH FINAL DIAGNOSIS BASED ON HISTOPATHOLOGY/CYTOLOGY

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ABSTRACT

BACKGROUND

CT has been one of the greatest inventions of the 21st century. In the right pair of hands, it can do wonders to a suffering patient. The time is not far where CT diagnosis will be considered a gold standard for the diagnosis of the thoracic lesions. Presently, the final diagnosis as a rule should be considered after taking histopathological confirmation. This study puts in a sincere effort to study and understand the signs of thoracic lesions and compare this data with that of the histopathological confirmation.

MATERIALS AND METHODS

The study was done in the Department of Radiodiagnosis at The Oxford Medical College Hospital and Research Centre. The duration of the study is for a period of 18 months from November 2015 to May 2017.

RESULTS

16 lesions were as being 61.54% of the total cases were diagnosed malignant. Two lesions were considered as being indeterminate.

CONCLUSION

The study satisfactorily proves the worthiness of CT in screening as well as its accuracy in proving the diagnosis of the thoracic lesions.

KEYWORDS

Imaging Signs, Thoracic Malignancy, Histopathology, Cytology.

HOW TO CITE THIS ARTICLE: Suresh P. A study of imaging signs of thoracic lesions and comparison of imaging diagnosis by computed tomography (CT) with final diagnosis based on histopathology/cytology. J. Evid. Based Med. Healthc. 2017; 4(48), 2925-2930. DOI: 10.18410/jebmh/2017/580

BACKGROUND

As the progression of pulmonary malignancy is high, pulmonary lesions need to be diagnosed early. Granulomas and bronchogenic cancers constitute the vast majority of pulmonary nodules. The incidence of malignant disease ranges from 10 to 70% with an average of 40%.[1] Other common causes of pulmonary nodules are hamartomas, metastases, infarcts, vascular malformations, focal inflammatory masses and lipoid pneumonia, etc. in decreasing order of frequency.[2]

A Solitary Pulmonary Nodule (SPN) is a round or oval opacity smaller than 3 cm in diameter that is completely surrounded by pulmonary parenchyma and is not associated with lymphadenopathy, atelectasis or pneumonia. Lung lesions greater than 3 cm in size are defined as lung masses.[3] A SPN is noted on up to 0.2% of chest radiographs.[3] Bronchogenic carcinoma is the commonest cancer in men and in women it comes after breast, colon and skin cancers. The single most important aetiological factor is cigarette smoking.

Metastatic lung disease in adults are usually from cancers of the breast, gastrointestinal tract, kidney, testes, head and neck tumours or from a variety of bone and soft tissue sarcomas. Haematogenous pulmonary metastases occur in the form of one or more discrete pulmonary nodules located usually in the outer portions of the lungs, a distribution that is most evident on CT.[4] The nodules are usually spherical and well defined, but they may be almost of any shape and can also have an irregular edge occasionally. Such irregular edges are seen particularly with metastases from adenocarcinomas. Cavitation is occasionally seen in pulmonary metastases, which is a particular feature of squamous cell carcinoma. Calcification is very unusual except in osteosarcoma and chondrosarcoma.[5] Even if the primary tumour shows calcification, e.g. in breast and colon, visible calcification in pulmonary metastases is rare. The rate of growth of metastases is highly variable in some choriocarcinomas and osteosarcomas; for example, it may be explosive and the lesions double in volume in less than 30 days.[6]

Financial or Other, Competing Interest: None.
Submission 25-05-2017, Peer Review 01-06-2017,
Acceptance 12-06-2017, Published 14-06-2017.
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DOI: 10.18410/jebmh/2017/580

Focal inflammatory lesions is another variety of lung lesions and CT is important for localising these lesions for TTFNAC and biopsy. Majority of them don't show characteristic features. CT may show an air bronchogram, which may suggest an inflammatory aetiology. Inflammatory masses with chest wall invasion include tuberculosis and actinomycosis where an aspiration can prove the diagnosis.[1] Lung abscess is difficult to diagnose on plain x-ray or CT when no air-fluid level is present. The presence of a central decreased density within a round or oval mass is typical. Intravenous contrast can show enhancement along the periphery and the abscess wall is usually thick and irregular. The differentiation from a cavitating primary or secondary neoplasm needs pathological evaluation.[6] Thymoma is the most common primary tumour of the anterior mediastinum. It usually occurs in patients over 20 years of age and is equally common in males and females. Eggshell calcification maybe seen in invasive thymoma. While benign thymomas generally have homogeneous attenuation, invasive thymomas may have more heterogeneous attenuation.[6]

Lymphadenopathy in the anterior mediastinum can be due to Hodgkin's Lymphoma (HL), Non-Hodgkin Lymphoma (NHL), sarcoidosis and other inflammatory conditions, infection and metastases. HL occurs in both men and women, usually those aged 20 to 30 years or over the age of 50 years. In the thorax, malignant lymphoma most commonly manifests as mediastinal lymphadenopathy.[5] Germ cell tumours of the mediastinum are believed to be derived from primitive germ cell elements left behind after embryonal cell migration. The mediastinum is the most common extragonadal site for these tumours, almost all of which arise in the anterior mediastinum within or in intimate contact with the thymus. Localised pleural tumours are relatively uncommon, the most common being a localised fibrous tumour. Malignant types are usually larger than 10 cm and may invade the chest wall.[1]

Pleural metastases are the most common pleural neoplasms. These are usually adenocarcinomas with the most common sites of origin being the ovary, stomach, breast and lung.[5] Diffuse thickening of the pleura can be caused by malignant mesothelioma or by pleural metastasis. The most common benign soft tissue tumour of the chest wall is a lipoma, but a variety of other mesenchymal tumours occur including neurofibromas (focal or plexiform), neurilemmomas, haemangiomas and lymphangiomas (cystic hygromas).[5] Malignant primary tumours arising in the soft tissues of the chest wall are unusual, the most common being liposarcoma or fibrosarcoma. Secondary tumours of the chest wall are common particularly when due to local spread (carcinoma of the breast and lung and lymphoma).[5]

The above bony thoracic structures can be affected by both inflammatory and neoplastic disorders. Destructive rib lesions occur most commonly in osteomyelitis or neoplastic disease.

Various primary and secondary tumours can affect ribs causing localised lesions. Non-neoplastic processes that may affect the sternum include osteomyelitis, histiocytosis X, Paget's disease, fibrous dysplasia and osteitis fibrosa cystica.[6] Neoplasms of the clavicle are usually malignant (myeloma or metastases). Other primary tumours and tumour-like lesions include osteosarcoma, Ewing's sarcoma, post-radiation sarcoma, aneurysmal bone cyst and histiocytosis.[1,5]

This study puts in a sincere effort to record and correlate the tissue procured by CT-guided interventional procedures with the cytopathological and histopathological findings in the diagnosis of thoracic lesions. This study is intended to benefit the practicing radiologists to identify and thus help to quickly diagnose and take desperate immediate interceptive measures to stop the natural progression of the disease.

Aims and Objectives

To record and correlate the material (tissue) procured by CT-guided interventional procedures (fine needle aspiration cytology, automated core needle biopsy) with the cytopathological and histopathological findings in the diagnosis of thoracic lesions.

MATERIALS AND METHODS

Informed Consent- Informed consent was taken from the patient or patient's relative after explaining to them about the interventional procedure proposed for the patient and the possible complications that may arise.

This is a hospital-based observational study of CT-guided interventional procedures in patients with thoracic lesions diagnosed by imaging methods like chest radiograph, CT or MRI scans. These patients were referred to the Department of Radiodiagnosis for CT-guided thoracic interventions from the Chest Medicine Department and other clinical departments of our hospital. The study was done in The Oxford Medical College, Hospital and Research Centre. The duration of the study is for a period of 18 months from November 2015 to May 2017.

Inclusion Criteria

- Patients with thoracic lesions referred for CT-guided core biopsy, fine needle aspiration cytology or drainage.

Exclusion Criteria

- Non-cooperative patients incapable of adequate breath holding.
- Uncorrected coagulation abnormalities.
- Patients at high risk for pneumothorax or haemothorax due to difficult access to the lesions.

The study includes patients with thoracic lesions situated in the lung parenchyma, mediastinum, pleura, bony thoracic cage and soft tissues of the thorax for diagnostic cytology or biopsy under CT guidance. Subjects were selected by preprocedural imaging diagnosis using chest radiography, computed tomography, magnetic resonance imaging or sonography. Bleeding and clotting parameters in the form of clotting time, bleeding time, prothrombin time and Activated Partial Thromboplastin Time (APTT) were determined in all patients. Subjects with normal bleeding and clotting

parameters were included in the study and the rest were excluded. Detailed history of patients was collected including medical history, occupation and personal history.

The nature of the lesions that was presented on CT was noted and then the specimen was collected using FNAC/CNB. The specimens that were thus procured were sent to the Department of Pathology for the final diagnosis.

Methods of Statistical Analysis

1. Descriptive analysis was adopted to present the study data using percentages and proportions.
2. Validation of CT in diagnosing benign and malignant lesions of the thorax (when compared with final pathological diagnosis) was undertaken by computing validity measures like sensitivity, specificity, positive predictive value and negative predictive value.

RESULTS

This hospital-based observational study had 26 patients, of which 13 were males and the remaining 13 were females. The age group of the patients in the study ranges from sixteen years to eighty years. Maximum numbers of patients were in the age group of 51 to 60 years with a value of 7 accounting for 27% of patients. This was followed by age groups of 41 to 50 years and 61 to 70 years, each of which comprised of 6 patients. Only one patient was in the age group of 11 to 20 years and no patient was aged below 10 years of age.

Age Group in Years	Male	Female	Total Numbers
Below 10	0	0	0
11 to 20	0	1	1
21 to 30	0	1	1
31 to 40	0	1	1
41 to 50	2	4	6
51 to 60	4	3	7
61 to 70	4	2	6
More than 70	3	1	4
Total	**13**	**13**	**26**

Table 1. Sex and Age Distribution of Patients

Out of the 26 patients in the study, only one patient was in the paediatric age group (less than 18 years of age). This patient was aged 16 years and had a large space occupying lesion in the right chest with extension to the left paraaortic region.

On evaluation of the thoracic lesions by CT, 16 lesions were attributed as being malignant, which accounted for 61.54%. Eight lesions were considered as benign and the remaining two lesions were considered as being indeterminate. The indeterminate lesions did not meet the CT criteria for benignity or malignancy and thus the lesion type had to be decided based on histopathological or cytological examination.

Total Number	Benign	Malignant	Indeterminate
26	8	16	2

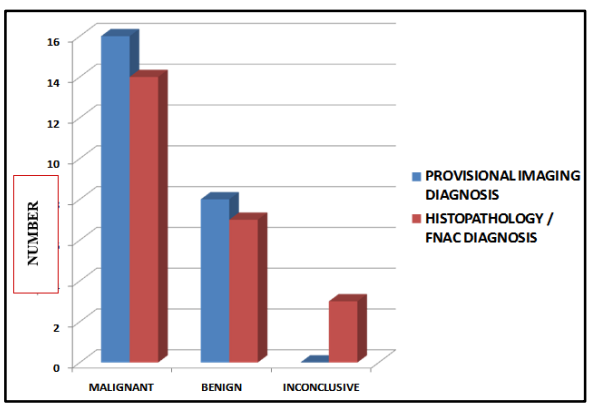
Table 2. CT Evaluation of Thoracic Lesions

Tissue	Number	Percentage
Benign	5	23.81
Malignant	14	66.67
Inadequate	0	0
Normal	2	9.52
Total	**21**	**100**

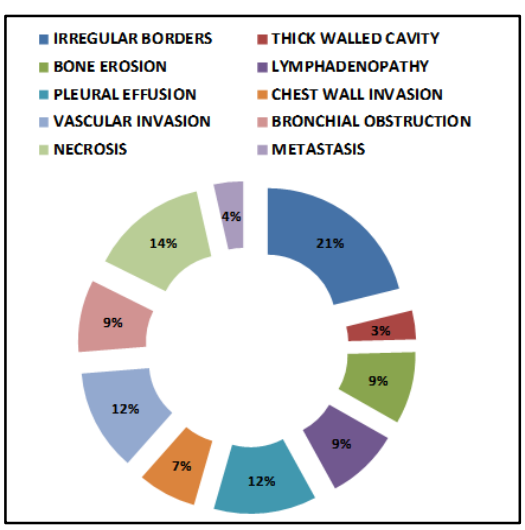
Table 3. Histopathology Report of Tissue Obtained by Core Biopsy

Tissue	Number	Percentage
Benign	2	28.57
Malignant	0	0
Inadequate	5	71.43
Normal	0	0
Total	**7**	**100**

Table 4. Cytology Report of Tissue Obtained by Fine Needle Aspiration



Graph 1. Benign and Malignant Lesions Based on Imaging and Pathological Diagnosis



Graph 2. Imaging Signs of Malignancy

Comparison of imaging diagnosis by CT with final diagnosis by histopathology/cytology for benign and malignant lesions of the thorax.

	Histopathology/Cytology Report		
CT	**Positive**	**Negative**	**Total**
Positive	6	2	8
Negative	1	15	16
	7	**17**	**24**

Table 5. Benign Lesions

CT sensitivity for benign lesions - 75%.
CT specificity for benign lesions - 93.75%.
Positive predictive value of CT - 75%.
Negative predictive value of CT - 93.75%.

	Histopathology/Cytology Report		
CT	**Positive**	**Negative**	**Total**
Positive	14	2	16
Negative	0	7	7
	14	**9**	**23**

Table 6. Malignant Lesions

CT sensitivity for malignant lesions - 100%.
CT specificity for malignant lesions - 77.78%.
Positive predictive value of CT - 87.50%.
Negative predictive value of CT - 100%.

DISCUSSION

Case 1- Male patient aged 67 years having a large right lung mass with pleural effusion who underwent CT-guided biopsy.

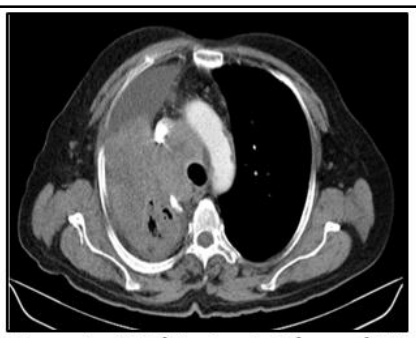


Figure 1a. Axial Contrast-Enhanced CT

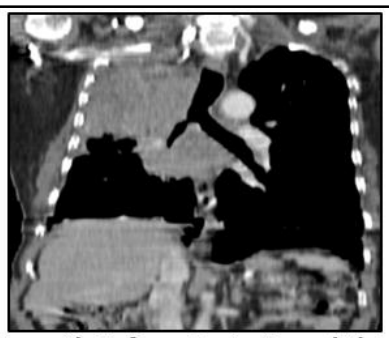


Figure 1b. Reformation in Coronal Plane

Poorly-differentiated small round cell tumour of right lung.

Case 2 - Male patient aged 86 years having a mass in the upper lobe of right lung who underwent CT-guided biopsy.

Figure 2a. Topogram

Figure 2b. Axial CT in lung window

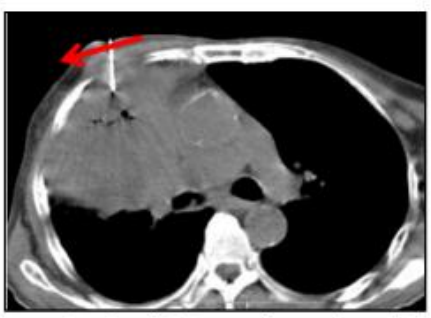


Figure 2c. Axial CT in mediastinal window with biopsy needle within the mass in the right upper lobe (arrow)

Moderately-to-poorly differentiated non-keratinising squamous cell carcinoma of right lung.

Case 3- Female patient aged 68 years who had a mass in the lower lobe of right lung with bilateral adrenal and right scapular metastases. The patient underwent CT-guided biopsy of the lung mass.

Figure 3a. Axial CT in Lung Window

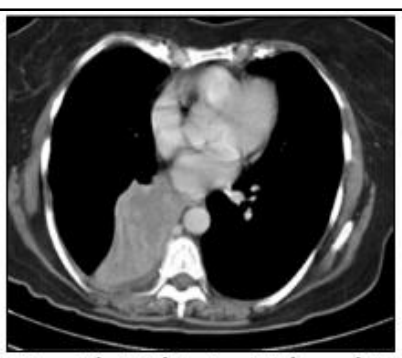


Figure 3b. Axial Contrast-Enhanced CT in window Showing Biopsy Needle

Figure 3c. Axial Prone CT in Mediastinal Window Mediastinal Window (Arrow)

Case 4- Female patient aged 55 years who had bilateral lung opacities. She underwent CT-guided biopsy of the left upper lobe opacity.

Figure 4a. Axial CT in Lung Window

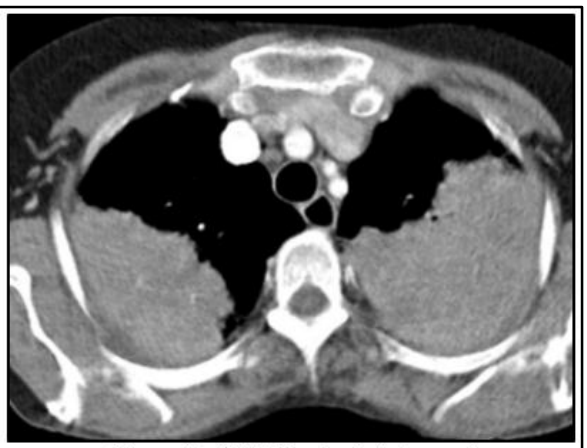


Figure 4b. Axial Contrast-Enhanced CT in Mediastinal Window

Figure 4c. Axial CT in Right Oblique Position Showing Biopsy Needle within the Lesion (Arrow)

Figure 4d. Reformatted Image in Coronal Plane

Bilateral Lung Tuberculosis

Image-guided thoracic interventions are the result of advancements in cross-sectional imaging. CT is the most commonly used imaging modality for thoracic interventions. These minimally-invasive thoracic interventions like CT-guided transthoracic lung biopsy and transthoracic fine needle aspiration cytology have become very popular for the diagnosis and management of thoracic lesions and hence more invasive procedures such as thoracoscopy, mediastinoscopy and thoracotomy can be avoided.[7]

This study was designed to determine the efficacy of CT-guided interventional procedures for the diagnosis of benign and malignant lesions of the thorax. In this hospital-based observational study, the total number of patients was 26, of which 13 patients were males and the remaining 13 were females. The age group of the patients ranged from 16 years to 80 years. Maximum number of patients were in the age group of 51 to 60 years with a value of 7 accounting for 27% of the total patients. This was followed by age groups 41 to 50 years and 61 to 70 years each of which had 6 patients. There were 4 patients aged above 70 years. Age groups of 11 to 20 years, 21 to 30 years and 31 to 40 years had one patient each. There was only one paediatric patient who was a female aged 16 years.

The 26 patients underwent imaging investigations like chest radiograph and CT scan for diagnosis of thoracic lesions. Then, CT-guided interventions, which comprised of percutaneous transthoracic core needle biopsy and transthoracic fine needle aspiration cytology were done after the patients gave written consent for the procedure and after through patient preparation was done as described previously. The patients were also explained in their own language, the type of procedure including risks and the complications like pneumothorax and pulmonary haemorrhage, which may arise after the procedure. All patients were subjected for bleeding and clotting parameters in the form of clotting time, bleeding time, prothrombin time and activated partial thromboplastin time. Subjects with normal clotting and bleeding parameters were included in the study and the rest were excluded.

The maximum number of patients with thoracic lesions was in the 51 to 60 years age group, which comprised of 7

patients. Thoracic CT revealed 16 lesions as being malignant based on certain imaging signs such as irregular borders, necrosis, bone erosion, chest wall invasion, vascular invasion, bronchial obstruction, etc., which were more common in these malignancies. Malignant lesions usually have irregular borders and areas of necrosis when seen on imaging. Malignant thoracic lesions may also invade the chest wall and adjacent vascular structures. They can invade bronchi and cause airway obstruction.[5] Five lesions were considered as being benign and the remaining five as indeterminate.

There was very good agreement between the lesions diagnosed by CT and those by pathology. Out of the 16 lesions attributed as being malignant based on CT findings, 14 were proved to be malignant by pathology. Among the 8 lesions attributed as being benign based on CT, 7 were proved to be benign lesions. In this study, benign lesions were most commonly situated in the upper lobe of the right lung and malignant lesions in the lower lobe of the left lung. The age group of 51 to 60 years was commonest for benign lesions in which there were four patients accounting for 57% of patients. For malignant lesions, the most common age group was 61 to 70 years, which had five patients accounting for 64%. Malignancies were most common in males accounting for 64% with a value of 9. The benign lesions were most common in females accounting for 71% with a value of 5.

The sensitivity, specificity, positive predictive value and negative predictive value of CT for diagnosing benign lesions of the thorax were 75%, 93.75%, 75% and 93.75%, respectively. Similarly, the sensitivity, specificity, positive predictive value and negative predictive value of CT for diagnosing malignant lesions of the thorax were 100%, 77.78%, 87.5% and 100%, respectively. These are represented in tables 13 and 14, respectively. Based on the review of literature, the sensitivity of CT for the diagnosis of benign lesions of the thorax is less than its sensitivity for the diagnosis of malignant thoracic lesions, while CT has a high specificity for the diagnosis of benign thoracic lesions when compared to its specificity for the diagnosis of malignant thoracic lesions.[8,9]

CONCLUSION

CT evaluation and CT-guided interventions are effective tools in the diagnosis and management of patients with thoracic lesions allowing prompt documentation of both benign and malignant lesions.

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