ACCURACY OF COMPUTED TOMOGRAPHY IN CHARACTERIZATION OF PULMONARY LESIONS

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ABSTRACT

OBJECTIVE: To determine the diagnostic accuracy of CT in characterization of pulmonary lesions taking histopathology as gold standard. **MATERIAL AND METHODS:** A prospective cross-sectional validation study was conducted from 01-12-2013 to 31-12-2015 at the Radiology department, Shifa International Hospital (Islamabad), Pakistan. One hundred and thirty-four patients with pulmonary lesions seen in prior chest x-rays or chest CT scans were referred to radiology department for CT guided biopsy. CT scan was performed for each patient prior to biopsy and CT evaluation of the pulmonary lesions was performed followed by CT guided Biopsy. Histopathological diagnosis of the lesion was taken as the gold standard. **RESULTS:** CT was found to be 96% sensitive, 82% specific and 94.6% accurate for diagnosing malignancy in solitary pulmonary lesions while PPV and NPV were 94% and 87% respectively using SPSS version 20. **CONCLUSION:** In our study CT, scan shows good performance in classifying pulmonary lesions as benign or malignant, however there is overlap among CT features of benign and malignant lesions. Therefore, lung biopsy is required for definitive diagnosis.
Keywords: Computed Tomography, pulmonary lesion

Introduction

Having the highest incidence of 1.3 million new cases annually, lung cancer is a leading cause of morbidity and mortality.[1] Although, Pakistan is considered a moderate risk area for men and low risk area for women, lung carcinoma was found out to be the most common cancer among men in the first report of Karachi cancer registry in 2000.[2]

Symptoms of lung cancer are non specific, and are noted in many other pulmonary pathologies. These include chest pain, recurrent pneumonias, persistent cough, sputum streaked with blood, bronchitis or voice change. They may be due to the malignant disturbances of hormones, blood or other systems, direct effects of the primary tumor or effects of metastatic tumors in other parts of the body. However, with a solitary pulmonary lesion found as an incidental finding on chest x-ray, one fourth of the patients are asymptomatic. Therefore, a detailed, structured diagnostic workup should be done, in which radiological evaluation plays a major part.[3]

For early detection and diagnosis of thoracic malignancies and to identify people with local disease, who may benefit from surgical resection, imaging plays an essential part. Thin slice imaging of the entire thorax can be done in a few seconds via the new generation scanners, with improved resolution and ability to detect nodules.[4]

SPL may be due to a variety of causes, including infectious, neoplastic, traumatic, vascular, inflammatory and congenital conditions. TB granulomas, hamartomas and intra pulmonary lymph nodes are categorized as benign SPLs, where as bronchogenic carcinomas constitute the malignant ones. Despite advances in different therapy modalities and multi-

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disciplinary approach, majority of the cases are diagnosed at an incurable stage. In theory all imaging modalities can help in diagnosing lung lesions, however, due to particular limitations in all the modalities, none can be considered a gold standard. Due to its high spatial resolution and volumetric data acquisition, multi detector CT has served the purpose of evaluation to a greater extent. Bronchoscopy, sputum cytology, percutaneous needle biopsy, thoracoscopy or open. However, they incur hospitalization and incur morbidity and since most of the cases are benign, it is not effective to perform biopsy in all cases.[5]

Ideally, mutidiciplinary approach to a suspicious lung lesion should result in removal of all malignant nodules, while benign nodules, should be avoided. However, effective means to implement such strategies don't exist since certain approaches which leave benign nodules intact, tend to leave some unresected malignant nodules while those which remove majority of malignant nodules tend to cause removal of benign ones. For patients who have stage 1A disease (T1N0M0) non-small cell lung cancer, resection survival rate may be as high as 70 to 80 percent with the latter approach.[6,7] In patients having early stage cancer and benign nodules, operative mortality rate is less than one percent. Unfortunately, only 20% of lung cancers are detectable at an early stage. Contrarily, unresected lung cancer are often fatal with the overall 5-year survival being just 7-13%. Different trials of screening have established that timely diagnosis, reduces morbidity and mortality and increases the chances of improving recovery and survival.[8]

The most widely used imaging modality to evaluate pulmonary nodules is Computed tomography (CT). The most effective method for correct diagnosis in suspicious pulmonary lesions is follow up by CT-guided percutaneous biopsies.[9] It is a safe and efficient method as it allows pathological verification of radiological diagnosis and is minimally invasive.[10,11,12] For small lung cancers in smokers, which can be easily cured, CT scan is increasingly being used for diagnosis. Helical low dose CT can detect very small tumors and is more sensitive than a regular radiograph.

Pulmonary metastases, which are a frequent feature of malignancies, should be included in the differential diagnosis of suspicious pulmonary lesions. Benign pulmonary lesions are caused by infectious granulomas, mostly due to endemic fungi or mycobacterium tuberculosis. Since pulmonary tuberculosis can cause significant drawbacks in radiological evaluation as it has a high incidence in Pakistan, and varying presentation.[13]

Determination of the diagnostic accuracy of CT diagnosis of malignant pulmonary lesions in Pakistani population was desired, along with attempts to differentiate tuberculous lesions from malignant lesions to improve specificity.

Materials and Methods

Cross sectional validation study was done at the Radiology department of Shifa International Hospital (SIH) Islamabad from 01-12-2013 to 31-12-2015. Ethical approval was taken from Institutional Review board and Ethics committee. A total of 134 patients with known SPLs who were referred to the radiology department for CT guided percutaneous biopsy were included in the study. All patient details such as clinical history, age and sex was recorded and Informed consent was taken from all patients. Plain CT slices of the chest with 10 mm interval were obtained from lung apex to diaphragm during breath-holding at mid inspiration.

On the basis of size of the lesion, its attenuation, its margins, and presence or absence of fat, cavitation and calcification, the lesions were characterized benign or malignant.

Scoring was done as follows:

a. No suspicion for malignancy: round, homogenous, well-defined-margins, <3 cm.

b. Low suspicion: round, non homogenous, well-defined margins, <3 cm.

c. Intermediate suspicion: well-defined margins, non homogenous attenuation, >3 cm.

d. Moderately high suspicion: irregular margins, non homogenous attenuation, >3 cm.

e. High suspicion: lobulated, spiculated margins, non homogenous attenuation, >3 cm.

Categories a, b, c are considered benign and categories d and e are considered malignant.[3]

Initial findings were confirmed by a consultant radio-

logist, followed by a CTguided percutaneous biopsy of the lesion. A consultant histopathologist documented the histopathology results.

Results

134 referred patients in total showed pulmonary lesions on CT scan during the period of study, which were subsequently biopsied under CT guidance and had histopathology done. All samples were adequate for histopathological diagnosis. Of the 134 patients, 100 were males and 34 female. A wide range of age was seen varying between 12 to 91 years with mean age 60 years and a standard deviation of 15 years. History of smoking was present in 85 patients, all males, 65 of which were later histologically proven to have lung cancer.

Out of the 134 cases, 102 (76%) were read on CT as having positive likelihood for malignancy. On later histopathological examination 96 (71%) of the total 134 cases had pulmonary malignancies. 6 were diagnosed with benign pathologies.

The malignancies included adenocarcinoma (n = 45), squamous cell carcinoma (n = 32), necrotic / malignant tumor (n = 4), large cell CA (n = 2), small cell CA (n = 1), metastatic adenocarcinoma (n = 4), adenosquamous (n = 3), non hodgkins (n = 1), B-cell lymphoma (n = 2), mucinous CA (n = 2), hodgkins (n = 1) mucoeperdemoid CA 1(n = 1), chondrosarcoma (n = 1) and fibrous tumor (n = 1).

histologically benign cases included tuberculous lesions (n = 17), necrotic lung tissue (n = 6), acute on chronic inflammation (n = 3), chondroid hamartoma (n = 1), pneumonea (n = 2), anthracosis and fibrosis (n = 3), fungal (n = 1), haemmorhage and edema (n = 1).

CT based diagnosis of benign lesion was made in 32 cases, 28 cases were proved out to be true negative however about 4 cases were diagnosed as false negative on biopsy. Thus there were 96 true positive, 6 false positive, 28 true negative and 4 false negative results reported on CT based assessment of likelihood of malignancy in these pulmonary lesions. Statistical parameters thus showed sensitivity of 96%, specificity of 82%, positive predictive value of 94%, negative predictive value of 87% and diagnostic accuracy of 92.5% for CT scan evaluation of suspicious pulmonary lesions.

Irregular margin with spiculations were seen in seen in all 96% of the malignant lung lesions. Non homogenous attenuation was the most frequently seen finding in the positive cases (94 cases). However, irregular margins were also observed in 5 benign lesions and non homogenous attenuation in 7 benign lesions.

Size greater than 3 cm was noted in a total of 100 cases, 92 of which were malignant. Malignancy was also diagnosed in 6 lesions measuring less than 3 cm in size.

Figure 1: A large soft tissue non homogenous mass in right lower lobe with irregular margins. On histopathology it was adencocarcinoma.

Figure 2: A small soft tissue mass in right upper lobe with lobulated, spiculated margins. On histopathology it was non small cell cancer of lung (NSCLC).

Cavitation with thick irregular walls was seen in only 13 cases, all of which were malignant. Four thick

walled cavity was detected in a lesion described as benign on both CT and biopsy reports.

Intranodular calcium was noted in 6 lesions, intranodal fat was not seen.

Figure 3: A large lobulated soft tissue mass in right upper lobe with irregular margins and a thin walled cavity (arrow). On histopathology it was tuberculosis.

Discussion

The most commonly used non invasive modality for evaluating pulmonary lesions in Pakistan is CT. It is crucial to evaluate the accuracy of CT in diagnosing malignancy so the diagnostic workup of such patients can be planned in a realistic manner. It has been noted that all three major criteria to diagnose malignancy i.e. size of the lesion, border characteristics and internal attenuation are sensitive, but can be seen in a variety of benign conditions as well.

In our series, 100 of the 134 pulmonary lesions were greater than 3 cm in size and out of these 92 were found to be malignant, while 8 lesions were less than 3 cm which were proved to be malignant on histopathology. This is in general agreement with published literature. In a study conducted by Steele et al,[14] 80 percent of solitary nodules larger than 3 cm in diameter were found to be malignant, compared to 20 percent of nodules less than 2 cm in diameter, while studies done by Zerhouni et al. and Siegelman et al. demonstrated that more than 90 percent of lesions larger than 3 cm are malignant.[15-16]

The most frequent criteria of malignancy seen in our study proved to be the border characteristics. In our study about 96 malignant lesions had irregular margins, a sensitivity of 96 percent; however, irregular margins were also seen in 6 of the 10 benign lesions.

Hence this finding is only 30% specific. Overall accuracy of this finding was calculated to be 87%. Conversely smooth margins are seen in 28 benign lesions , however 6 benign lesions do showed irregular margins. During the literature review we came across a study by Rigler et al. in which they determined that a smooth border has a 20 percent likelihood of representing a malignant nodule. However the likelihood increases to 60 percent with a scalloped border, 90 percent with spiculations and 95 percent in the presence of a corona radiata.[17]

In our study the second most recurrent feature suggestive of malignancy, after irregular margins, was non-homogenous attenuation. It is noted that while non-homogeneity was a very sensitive indicator of malignancy it was observed in both malignant and benign lesions. Out of 100 malignant lesions 94 were non-homogenous and 6 homogenous (sensitivity of 94%), while amongst 34 benign lesions 7 showed non-homogenous attenuation and 27 were homogenous (specificity of 82%) .

The most common pathology mimicking malignancy was tuberculosis. In our study there were 6 such cases, 4 males, 2 females, in age range of 36 to 76 years. As the CT characteristics of these lesions are same as to those of malignant lesions. Four of them measured more than 3 cm in size, all had irregular margins and had non-homogeneous attenuation. One had an associated small cavity with a thin wall of 4 mm thickness. Thin wall calcification was seen in one of these lesions. On the basis of these findings all were labeled as malignant on CT diagnosis.

Cherian et al., in his study of atypical pulmonary patterns of tuberculosis found that the most common of these unusual radiographic patterns of tuberculosis was mass-like densities, most of which were initially and mistakenly diagnosed as neoplasms.[18] Similar was the result in our study and is a major concern in our set up since TB has high prevalence in Pakistan.[19] We failed to identify any criteria which could improve the sensitivity or specificity for recognizing atypical TB lesions on CT scan. Similar atypical CT radiologic manifestations of tuberculosis, seen in as many as one third of the cases of adult-onset tuberculosis were described by Lee et al.[20]

Comparatively low specificity seen in our study as compared to other studies[21,22] is primarily attributable to these tuberculous lesions. Another limitation was

that no dynamic imaging was performed after contrast administration. The study was conducted in a single centre and only those patients were included who had known SPLs on prior radiographic evaluation thus creating selection bias in the study.

Conclusion

In our study CT scan shows good performance in classifying pulmonary lesions as benign or malignant, however there is overlap among CT features of benign and malignant lesions. Therefore lung biopsy is required for definitive diagnosis. CT is a good localizing tool for pulmonary lesions prior to CT guided percutaneous biopsies. So this combination of imaging and biopsy is cost effective, relatively easily available and highly accurate in diagnosing malignancy in pulmonary lesions. We were unsuccessful in establishing any CT criteria which could improve the CT diagnostic accuracy for diagnosing atypical tuberculous lesions.

Conflict of Interest: No financial or institutional conflict of interest.

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