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Original Research Article

Relationship between radiographic activity on chest computed tomography and microbiological yield in pulmonary tuberculosis cases

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ABSTRACT

Background: Despite the widespread clinical use of computed tomography (CT), is known regarding the relationship between radiographic activity and microbiological yield in cases of suspected pulmonary tuberculosis (PTB) detected on a CT scan in the chest.
Methods: Utilizing data from medical records across multiple centers, we looked at the diagnostic performance for certain PTB. Based on radiographic activity, we divided the patients into four groups: definitely active, possibly active, probably inactive and indeterminate activity.
Results: Out of the 162 patients that were included, 79 had PTB that was verified by culture; these patients were categorized into four groups: Undoubtedly active, most likely active, unclear activity, and most likely inactive. These patients made up 48 (29.2%), 81 (49.7%), 17 (10.8%), and 16 (10.3%). In addition to culture rates, TB-PCR and histology data revealed 66.6%, 67.2%, 14.3%, and 0% of each CT radiography procedure respectively, were considered as definitive PTB. Radiography procedure demonstrated good negative predictive values (92.7%, 95% CI, 86.6–96.2) and strong sensitivity (97.1%, 95% confidence interval (CI), 94.6–98.5), which were deemed certainly and probably active PTB in terms of diagnostic efficacy for a certain PTB. According on radiographic activity, respiratory illnesses such non-tuberculous infections caused by mycobacterial and bacterial pneumonia were the most common etiologies other than tuberculosis.
Conclusions: Radiographic activity performed well in diagnostics and is readily applicable in therapeutic settings. Nonetheless, physicians must to contemplate alternative options, as radiologic pictures do not validate microbiological patient testing.

Keywords: PTB, CT, Radiographic activity, MTB culture yield

INTRODUCTION

A key component when PTB is diagnosed is chest CT.[1] Due to its speed, chest radiography is often utilized as the initial diagnostic technique; nevertheless, it has drawbacks, including low specificity and inconsistent readings.[2-5] Therefore, it's critical to overcome this drawback. Early PTB lesions can be identified by chest CT scan and differentiated from those from other etiologies.[1,6,7] Additionally, it can offer more details about the action of mycobacteria of tuberculosis lesions.[8]

Using chest CT, early research assessed the radiologic and pathologic association and described the radiological features of PTB as "cavitation," "tree-in-bud," and "consolidation".[9,10] Subsequent research endeavours aimed to determine the correlation between every radiographic characteristic and the sputum smear grade or Mycobacterium tuberculosis (MTB) culture yield.[11-13] To ensure appropriate management, it is critical for clinicians overseeing PTB treatment to predict the MTB culture yield determined by CT. Sadly, PTB finds that the findings of earlier research, broken down into radiographic presentation, are too intricate to be used as a

diagnostic tool in clinical settings. Furthermore, depending on the techniques employed in the culture media, the culture yield may be underestimated. Too far, no research has examined these constraints.

Thus, in patients who were suspected of having PTB, we assessed the relationship between the categorized radiographic grade on a chest CT scan and the microbiologic output of MTB using bronchoscopy. In clinical practice, the classified grade is easily applicable. The most effective and potent method for diagnosing PTB is bronchoscopy, which also possesses the capacity to discriminate.[14,15]

The purpose of this study was to ascertain the proportions of cultures that are MTB-positive in presumed PTB patients based on radiographic grades obtained from chest CT scans; and assess the relationship between radiography procedures and PTB. Determine the alternative cause based on radiography grades.

METHODS

Study population design

Patients over the age of eighteen who had suspicious PTB from January 2020 to February of 2023 were included in this retrospective review. Patients who had bronchoscopy and chest CT for PTB diagnosis were included based on the enrolment criteria.

PTB radiologic activity classification using chest CT

One radiologist from each institution reviewed the chest CT scan, and they were all oblivious to the microbiological findings. Based on previously published criteria, patients with presumed prostate cancer were divided into four groups. According to radiography procedures, grade range from greatest to lowest: unquestionably active, with damage that include a cavity; most likely active, with several non-calcified, weakly defined nodules without a cavity or a "tree-in-bud" appearance; both certainly inactive, with lesions mostly showing as fibrotic bands or calcified nodules, and unclear activity, with lesions primarily appearing as non-calcified, firmly outlined nodules.[10,17-19] The radiography procedures were deemed to be of a higher level if the lesion of the indicated PTB fell into two or more of the previously mentioned categories.

Bronchoscopy procedure and microbiological examination

The faculty members of each hospital's pulmonology division performed bronchoscopies. Individual bronchoscopists made the decision between bronchoalveolar lavage (BAL) and bronchial washing (BW) during bronchoscopy. BW or BAL was performed on the most severe damage when the several lesions associated with the recommended PTB were seen on CT. The prescribed processing and pretreatment were applied to all of the specimens under a microscope that are utilized for acid-fast bacilli (AFB) cultures.[20] Following auramine-rhodamine fluorescence staining, the AFB smears were evaluated and scored on a range of 0 to 4+.[21]

Statistical analysis

For continuous parameters, the records shown as the median and Interquartile range and for categorical variables, as the number (%). For continuous parameters, the Mann-Whitney U test was used to compare the data, and for categories of variables, Pearson's chi-square test or Fisher's exact test were employed. We assessed the radiography to ascertain how accurate it was in predicting PTB. For each type of radiographic activity, the Youden index was determined, which is defined as (sensitivity + specificity)-1. The ideal cut-off was defined as the level of when there was radiographic activity, the Youden index was greatest. Every test was conducted in duplicate, with a p value of less than 0.05 deemed significant. Version 24 of IBM SPSS Statistics was used to analyse the data.

RESULTS

Due to suspected PTB, 182 individuals had bronchoscopies and chest CT scans performed during the study period. Out of these patients, 20 were deemed to be excluded. Thus, 162 patients met the eligibility requirements; of them, 47 patients (29.2%) were categorized as certainly active, 81 (49.7%), as probably active, 17 (10.8%), as uncertain activity, and 17 (10.3%), as probably inactive. Table 1 provides a summary of the enrolled cases' descriptive and demographic characteristics. The median age of the 92 (56.9%) males was 57.0 (41.0-71.0) years. The majority of patients who were included had single-lobe lung parenchyma PTB.

Table 2 displays the specificity for PPV, and NPV for both overall and definite PTB based on the radiographic activity on CT. Low sensitivity but moderate specificity was seen within the most likely and certainly active groups, respectively, in predicting definite and overall PTB. The definitely and probably active groups, on the other hand, were thought to indicate active PTB when combined; they had a high NPV and sensitivity but lesser specificity and a tiny PPV. The best radiographic cut-off factors to forecast definitive and comprehensive.

Table 3 presents the final diagnosis based on radiographic activities for the enrolled cases. Most frequently, bacterial pneumonia was the source of parenchymal lung damage in virtually all patients (PTB excluded), and it was followed by PNTM.

In the cases that were ultimately determined to have bacterial pneumonia, we further examined the distribution of the microbiological etiologies (Table 4), but no statistical differences were found.

Table 1: Clinical and demographic features of 162 individuals with suspected PTB.

Variables	N (%) or median (IQR)
Age (in years)	57.0
Sex % of male	92 (56.9)
Comorbidity	
Chronic obstructive pulmonary disease or asthma	7 (4.3)
Thyroid disease	2 (1.2)
Malignancy	5 (3.1)
Cardiovascular disease	14 (8.6)
Hematologic disease	1 (0.6)
Chronic liver disease	6 (3.7)
Chronic kidney disease	6 (3.7)
Rheumatic disease	7 (4.3)
Diabetes	8 (4.9)
Neurologic disease	3 (1.8)
Cerebrovascular disease	2 (1.2)
HIV infected	1 (0.6)
Immune suppressive disease	2 (1.2)
Bronchoscopic specimen	
BAL	55 (34)
BW	107 (66)
Radiographic activities based on chest CT	
Probably active	81 (50)
Definitely active	47 (29)
Indeterminate activity	17 (10.5)
Probably inactive	17 (10.5)
Extent of lung lesion	
Multilobar involvement	69 (42.5)
Unilobar involvement	93 (57.5)

Table 2: Features of research subjects based on radiographic actions on chest CT scans.

Variables	Probably active, (n=81) (%)	Definitely active, (n=47) (%)	Indeterminate activity, (n=17) (%)	Inactive, (n=17) (%)	P value
Overall PTB	61 (75.3)	34 (72)	4 (23.5)	2 (12)	Less than 0.001
Definite PTB	54 (66.9)	32 (68)	2 (12)	0	Less than 0.001
Genetically confirmed PTB	5 (6.1)	3 (6.3)	2 (11.7)	0	
Histologically confirmed PTB	1 (1.2)	0	1 (5.8)	0	
Microbiologically confirmed PTB	49 (60.5)	29 (61.7)	1 (5.8)	0	
Probable PTB	3 (3.7)	6 (12.7)	1 (5.8)	2 (12)	
Extent of lung lesion					0.189
Multilobar involvement	32 (39.5)	23 (48.9)	7 (41.1)	6 (35.2)	
Unilobar involvement	48 (59.2)	25 (53.1)	10 (58.9)	11 (64.7)	

Table 3: Complete diagnosis of 162 patients suspected of having PTB.

Variables	Probably active, (n=81) (%)	Definitely active, (n=47) (%)	Probably inactive, (n=17) (%)	Indeterminate inactive, (n=17) (%)
Unidentified	2 (2.5)	1 (2.1)	7 (41.1)	1 (5.9)
Viral pneumonia	1 (1.2)	0	0	0
Sarcoidosis	0	0	0	0
Pneumocystis jirovecii pneumonia	0	0	0	0
Chronic cavitary pulmonary aspergillosis	0	0	0	0

Continued.

Variables	Probably active, (n=81) (%)	Definitely active, (n=47) (%)	Probably inactive, (n=17) (%)	Indeterminate inactive, (n=17) (%)
Lung cancer	1 (1.2)	2 (4.2)	0	0
Bacterial pneumonia	11 (13.5)	7 (14.8)	7 (41.1)	10 (58.8)
Pulmonary non-tuberculous mycobacteria	5 (6.1)	4 (8.5)	1 (5.9)	2 (11.7)
PTB	61 (75.3)	34 (72.3)	2 (11.7)	4 (23.5)

Table 4: Microbial etiology of finally diagnosed bacterial pneumonia according to radiographic activity.

Bacterial pneumonia	Probably active, (n=11) (%)	Definitely active, (n=8) (%)	Probably inactive, (n=7) (%)	Indeterminate activity, (n= 9) (%)	P value
Streptococcus pneumoniae	0	1 (12.5)	0	0	0.712
Other *Streptococcus spp.*	2 (18.1)	2 (25)	1 (14.2)	3 (33.3)	0.730
Staphylococcus aureus	0	0	0	1 (11.1)	0.301
***Pseudomonas* spp.**	1 (9)	0	0	0	0.320
Stenotrophomonas maltophilia	0	0	0	0	0.251
Mycoplasma pneumoniae	0	0	0	0	-
***Klebsiella* spp.**	2 (18.1)	2 (25)	1 (14.2)	0	0.171
Haemophilus influenzae	0	0	0	0	-
***Enterobacter* spp.**	0	0	0	0	-
***Acinetobacter* spp.**	0	0	0	0	-
Others	0	0	1 (14.2)	2 (22.2)	0.613

DISSCUSION

In patients with suspected PTB, the study assessed the relationship between radiography procedure on chest CT and microbiological yield. The culture rates of each radiography procedure in this real-world study were 61.6%, 60.7%, 4.3%, and 0%, in that order. The radiography activities demonstrated good sensitivity and NPV with regard to the specific and comprehensive PTB's diagnosis. These results imply that radiographic activity can be utilized in clinical practice to diagnose PTB and to guide anti-TB treatment in the early stages for presumed PTB. This is the first study to assess the relationship between radiography procedure on chest CT and microbiologic yield in instances with suspected PTB in real-world settings.

PTB's high morbidity and mortality rate have historically made it the most difficult infectious lung illness for doctors to treat. On the other hand, scant information has been published on the relationship between microbiological yield and CT radiography procedure in instances of suspicious PTB. Furthermore, microbiological PTB cannot be confirmed by the CT shadow of the lung lesion.[30]

Because PTB has potentially dangerous consequences, researchers have previously attempted to characterize the radiographic features and behaviors of the condition in order to detect it early and stop its transmission.

Numerous radiologic characteristics, including cavities, anatomical sites were suggestive of active PTB in numerous earlier studies.[8,10,12,17,18,22-27,29] Furthermore, based on chest CT, various research investigations categorized and gave the radiographic requirements for PTB procedures.[10,14,17,18] According to the degree of the radiographic activity, several Research looked forward at the reasons of individual radiologic patterns, such as tree-in-bud or cavity.[25,28,29] However, there is lesser information regarding the general causes of presumed pneumonia based on chest CT. While determining the radiologic features of definitive PTB is crucial, determining the relative incidence of definite PTB in patients who are suspected of having PTB based on a CT scan of the chest is more significant and helpful in clinical practice.

By using bronchoscopy, which is thought to be the most effective diagnostic technique for PTB, we sought to determine the relative frequency of microbiologically proven PTB using previously reported radiography procedures criteria based on a chest CT scan. Based on the morphological features of chest CT, we found in this study a strong association between radiographic activity and the confirmation of PTB by microbiology. Clinicians will find this material helpful in the PTB evaluation and in guiding the initiation of anti-TB medication for individuals who may be suspected of having PTB.

Since bronchoscopy allows for the differentiation of various etiology from PTB, we limited the enrolment of patients in this study to those who had this procedure. In addition, the number of confirmed PTB cases associated with each radiographic activity may have been

overestimated due to the fact that 57.9% of the included patients had localized disease and were diagnosed by bronchoscopy. In contrast to earlier research, this inclusion might have reduced the percentage of undetected cases.[27,30] Secondly, there were variations in the CT scan protocol among the individuals that were enrolled. This might have had an impact on the morphological traits necessary for certain nuanced discoveries.

CONCLUSION

Conclusively, the radiography procedures, derived from chest CT scans, demonstrated a moderate association considering MTB's microbiological output. When combined with lesions that were most likely active, they performed well for the PTB diagnosis. The study's findings imply that the radiography procedure, which depends upon chest CT, can be applied in clinical settings with ease. However, as radiologic pictures do not support microbiological PTB, doctors should take into account alternatives to PTB.

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