https://doi.org/10.29309/TPMJ/2024.31.05.7959

The Professional Medical Journal
www.theprofesional.com
2024, Volume, 31 Issue, 05

ORIGINAL ARTICLE

Diagnostic accuracy of high resolution computed tomography (HRCT) of chest in diagnosing sputum smear positive and sputum smear negative pulmonary tuberculosis (PTB).

Maria Naseer[1], Salahuddin Balooch[2], Umar Amin[3], Muhammad Amin[4], Muhammad Usman Khan[5], Madeeha Anwar[6]

Article Citation: Naseer M, Balooch S, Amin U, Amin M, Khan MU, Anwar M. Diagnostic accuracy of high resolution computed tomography (HRCT) of chest in diagnosing sputum smear positive and sputum smear negative pulmonary tuberculosis (PTB). Professional Med J 2024; 31(05):738-743. https://doi.org/10.29309/TPMJ/2024.31.05.7959

ABSTRACT… Objective: To assess the diagnostic accuracy of high resolution computed tomography (HRCT) of chest in diagnosing sputum smear positive and negative pulmonary tuberculosis (PTB). **Study Design:** Cross-sectional study. **Setting:** Tertiary Care Hospital, Kharian Cantt. **Period:** Oct 2021 to April 2022. **Methods:** The retrospective reviews of medical records of patients undergone HRCT chest and sputum for AFB smear and culture due to pulmonary tuberculosis (PTB) suspicion were included. The HRCT and AFB findings for sample size of 220 was compared. SPSS was used to stratify outcomes on basis of sputum smear results. Diagnostic accuracy of HRCT chest was calculated by taking AFB as gold standard. The AFB findings and HRCT outcomes were compared through correlation analysis and paired t-test with p value < 0.05 considered as significant. **Results:** The sensitivity was found to be 86.23% with specificity of 86.48%, positive predictive value of 86.23%, negative predictive value of 86.48% and diagnostic accuracy of 86.36% for HRCT for diagnosing pulmonary tuberculosis (PTB). **Conclusion:** HRCT chest affirms high diagnostic potential for pulmonary tuberculosis (PTB) and should be used as a routine diagnostic tool for the disease.

Key words: Computed Tomography, Diagnostic Accuracy, Tuberculosis.

INTRODUCTION

Tuberculosis (TB) is an infection caused by Mycobacteium tuberculosis (MTB). It is responsible for causing three million deaths per year, but still considered as the world's most neglected crisis by World Health Organization (WHO).[1] It mostly affects lungs but other parts of body can also get affected.[2] However, many individuals do not show symptoms of the disease, where it is called latent tuberculosis.[3] General symptoms include weight loss, fever, cough with blood, weakness and night sweats.[4] Pulmonary tuberculosis (PTB) is an important health disorder that is considered to affect about one-third of the world population. Each year about 2% of world population develops tuberculosis (TB).[5] In the developing country of Pakistan, tuberculosis exists as an endemic, which makes it an important disease to be explored. In 2018, 6% of world TB cases were reported from Pakistan. Developed countries may also get affected by pulmonary tuberculosis due to immigrants from developing countries.[6]

Many diagnostic tests have been put forwards for diagnosing pulmonary tuberculosis. Real-time polymerase chain reaction (RT-PCR) is preferable at regions where resources are limited. C reactive protein (CRP) can also be used for identifying presence of pulmonary tuberculosis[7]. The Xpert mycobacterium tuberculosis/rifampin (Xpert MTB/RIF) is a highly recommended test for diagnosis of pulmonary TB. An extension of this test is the Xpert MTB/RIF Ultra with enhanced sensitivity.[8]

Radiological imaging plays eminent role in assessing the pulmonary TB. Chest radiography is required for evaluating TB on initial basis.

1. MBBS, Resident Radiology, CMH Kharian.
2. MBBS, FCPS, Associate Professor/Consultant Radiologist, PAF Hospital, Mushaf.
3. MBBS, FCPS, Associate Professor Radiology, Akhtar Saeed Medical College, Rawalpindi.
4. MBBS, FCPS, Assistant Professor Pulmonology, CMH Kharian Medical College, Kharian.
5. MBBS, FCPS, Associate Professor Radiology, CMH Quetta.
6. MBBS, FCPS, Consultant Pathologist, CMH, Okara.

Correspondence Address:
Dr. Salahuddin Balooch
Department of Radiologist
PAF Hospital, Mushaf.
jagartoos1977@gmail.com

Article received on: 27/10/2023
Accepted for publication: 29/12/2023

Pulmonary tuberculosis is depicted through consolidation, enlarged lymph nodes, pleural effusion and miliary nodules on imaging.[9] Post-primary tuberculosis is characterized by apical consolidation, cavitation and nodules.[10] Previous research work indicates that high resolution computed tomography (HRCT) has about 90.9% sensitivity and 96.4% specificity in diagnosing pulmonary TB.[11] The merit of distinguishing active from chronic infection through distribution of Computed Tomography (CT) signs make use of HRCT more applicable for pulmonary TB.[11] As it is important to use accurate way of diagnosing, the present study aims to assess diagnostic accuracy of HRCT chest in diagnosing sputum smear positive and negative pulmonary TB with acid-fast bacillus (AFB) culture as gold standard. This will help in understanding the role and applicability of HRCT in diagnosis of TB. Moreover, this work will be helpful for practitioners in terms of selection of appropriate modality for the diagnosis of pulmonary TB.

METHODS

The present cross-sectional study was conducted at Tertiary Care Hospital Kharian Cantt from October 2021 to April 2022. For this purpose, the retrospective reviews of medical records of patients undergone HRCT chest and sputum for AFB smear and culture due to pulmonary TB suspicion were included. The sample size of 220 was calculated by Raosoft calculator in accordance with 0.34% prevalence of TB in Pakistan with 70.8% prevalence for pulmonary TB[12] with 99% confidence interval and 1% margin of error. The Institutional Ethical Review Board gave written Permission for the study via Institutional ethical committee reference no 4963.

The inclusion criteria was any gender with age 20 to 50 years with suspicion of pulmonary TB. The suspicion was based on the symptoms of the disease including shortness of breath, fever, night sweats, weight loss and productive cough with or without hemoptysis. The exclusion criteria was anti-tuberculous therapy (ATT) and inability to produce sputum. At least 2ml was considered appropriate for sputum smear test. Tuberculosis was characterized by consolidation, fibrotic changes, cavitation, pleural effusion, bronchiectatic changes, centrilobular nodules, ground-glaze haze and calcified granulomas, and branching nodules with tree in bud appearance with or without lymphadenopathy on HRCT. Lowenstein-Jensen (LJ) medium was used for AFB culture. The growth of mycobacteria indicated positive result, whereas, absence of growth indicated negative result.

The data was analyzed by Statistical Package for Social Science (SPSS) v.20. Qualitative variables such as gender, HRCT, findings of sputum smear test and AFB culture were presented as frequencies and percentages, whereas, quantitative variable such as age was depicted as mean and standard deviation. Stratification was done based on sputum smear results. AFB culture was taken as gold standard to calculate diagnostic potential of HRCT chest including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy by 2x2 table. The AFB findings and HRCT outcomes were compared through correlation analysis and paired t-test with p value of 0.05 considered as significant.

RESULTS

The Table-I shows baseline characteristics of patients included in the study. According to which, mean age of patients was 33.49 ± 7.5 years. The study comprised of 105 (47.7%) male individuals and 115 (52.3%) female individuals making female population in majority. The sputum smear test was positive for 109 (49.54%) patients and negative for 111 (50.45%) patients. On the other hand, same results were obtained for AFB culture test.

Characteristics of Participants	Frequency N (Percentage %)
Age (years)	33.49 ± 7.5
Gender	
Male	105 (47.7%)
Female	115 (52.3%)
HRCT	
Positive	109 (49.54%)
Negative	111 (50.45%)
AFB culture test	
Positive	109 (49.54%)
Negative	111 (50.45%)

Table-I. Baseline characteristics of participants

The Table-II shows findings of HRCT for pulmonary TB. According to which, symptoms of tree-in-bud (76%), fibrotic changes (73%), consolidation (66%), cavity (41%), ground-glass haze (17%), bronchiectasis (17%) and calcific granuloma (11%) were eminent.

HRCT Findings	Disease Positivity (%)
Tree-In-Bud	76%
Fibrotic changes	73%
Consolidation	66%
Cavity	41%
Ground-Glass Haze	17%
Bronchiectasis	17%
Calcific granuloma	11%

Table-II. Findings of HRCT in PTB

The Table-III shows comparative results of HRCT and AFB. There were 94 (42.7%) true positives (TP) and 96 (43.6%) true negatives (TN). However, 15 (6.8%) false positives (FP) and 15 (6.8%) false negatives (FN) were also detected.

The Table IV shows diagnostic attributes of HRCT. The sensitivity was found to be 86.23% with specificity of 86.48%. The positive predictive value (PPV) was 86.23%, whereas, negative predictive value (NPV) was 86.48%. Diagnostic accuracy was found to be 86.36%.

The Table-V shows association between HRCT and AFB findings through correlation analysis and paired t-test. The correlation value was found to be 0.736 (0.1 to 0.3 for low association; 0.3 to 0.5 for moderate association; 0.5 to 1 for high association) with a significance value of $p < 0.000$ shows that a highly significant association is present between HRCT and AFB findings. Thus, results for both the diagnostic tools have similar findings for diagnosis of PTB.

DISCUSSION

There are many diagnostic approaches for identification of tuberculosis. However, each one is affiliated with some disadvantage. AFB culture take few weeks.[13] Despite this fact, AFB culture is considered as gold standard for pulmonary TB diagnosis. On the other hand, sputum smear negativity along with suspicion of pulmonary TB is extremely crucial diagnostic challenge. Many biochemical tests are also present but they are not widely accessible and available.[14] This makes the use of imaging important in assessment of pulmonary TB. Apart from diagnosis, imaging has benefits of evaluating treatment response and complications related to the disease. It can also help in starting the empirical treatment of disease.[15] The present study was performed to assess the diagnostic potential of HCT by keeping AFB culture as gold standard.

HRCT Chest Findings	AFB Culture Findings		Total n (%)
	Positive n (%)	Negative n (%)	
Positive n (%)	94 (42.7%) (True positive; TP)	15 (6.8%) (False positive; FP)	109 (49.54%)
Negative n (%)	15 (6.8%) (False negative; FN)	96 (43.6%) (True negative; TN)	111 (50.45%)
Total n (%)	109 (49.54%)	111 (50.45%)	220

Table-III. Comparative results of HRCT and AFB

Factors	Formulas	Calculations	Results (%)
Sensitivity	TP/ TP + FN x 100	94/94 + 15 x 100	86.23%
Specificity	TN/ FP + TN x 100	96/15 + 96 x 100	86.48%
Positive predictive value (PPV)	TP/ TP + FP x 100	94/94 + 15 x 100	86.23%
Negative predictive value (NPV)	TN/ FN + TN x 100	96/15 + 96 x 100	86.48%
Diagnostic accuracy	TP+TN/ TP+FP+FN+TN x 100	94+96/94+15+15+96 x 100	86.36%

Table-IV. Calculation of diagnostic attributes of HRCT for PTB

Relation Test	Values
Pearson Correlation	0.736
p value	<0.001

Table-V. Relationship statistics between HRCT and AFB for PTB

Pulmonary tuberculosis can be classified as primary and post-primary TB with different radiological features and some common features. Primary TB has impact on lymph nodes, lung parenchyma, tracheobronchial or pleura tree. The formation of Ghon/ Ranke complex has been affiliated with primary TB. On the other hand, post-primary PTB takes place in already infected patients due to immunosuppression or malnutrition.[16]

The present study showed that HRCT have sensitivity of 86.23%, specificity of 86.48%, positive predictive value (PPV) of 86.23%, negative predictive value (NPV) of 86.48% and diagnostic accuracy of 86.36% in diagnosing PTB. A similar research work[17] affiliated 89.09% sensitivity, 79.25% specificity, 81.67% PPV, 87.50% NPV and 84.26% diagnostic accuracy with HRCT in diagnosing pulmonary tuberculosis (PTB). Another research work[18] documented 93.5% sensitivity, 99.5% specificity, 99.5% NPV of HRCT for pulmonary tuberculosis (PTB). Another study[19] postulated 87.5% sensitivity, 99% specificity, 94.6% PPV and 97.6% NPV with HRCT in diagnosis of pulmonary tuberculosis (PTB). The variation in values of diagnostic potential can be attributed to the epidemiological differences in PTB prevalence and risk factors. Another important reason can be the variation in scanning parameters of HRCT.

Previous research works have also compared HRCT with MRI. Both the diagnostic tools have similar diagnostic potentials.[20] On the other hand, combined application of HRCT with serological testing has also been recommended for improved diagnosis of TB[21]. Previous research works have shown similar results for HRCT and interferon gamma releasing assay (IGRA), whereas, use of HRCT has been preferred over Gene Xpert.[22] The findings of present research work suggests similar diagnostic potentials for AFB and HRCT.

HRCT has ability to distinguish pulmonary TB through characterization including micronodules, airspace consolidation, the tree in bud appearance, ground-glass opacities, nodules and cavities.[23] The fibrotic changes are most common appearance with involvement of posterior segment of apical zones. Due to poor oxygenation, multiple calcified lesions are eminent at apical regions of upper and lower lobes of lungs. Usually it is apparent as consolidation in starting phase.[24] In the present study, 66% of patients showed consolidation apart from other characterized appearance. The consolidation links with secondary bronchioles, which forms cavities that are responsible for spreading the disease towards lungs and other important organs of the body. The progress of disease is not depicted though routine X-ray chest. However, literature elaborates that sputum negative test are at lower risk of disease spread in comparison to sputum positive patients. The transmission capability of smear negative individuals has been estimated to be 22%. Another important characteristic is the tree in bud appearance (TIB).[25] The present study showed this attribute to be present in 76% of the positive cases. This appearance has been affiliated with mycobacteria (39%), aspiration (25%), multiple infections (4%) and viruses (3%).

Ground glass patches depicts acute form of disease that usually involves lower lobes. On the other hand, cavities in upper lobes or apical region of patient shows initial stage of disease. These cavities may be surrounded by small nodules.[5] In present study, 41% of the patients showed cavities as an eminent feature. These cavities have potential to depict acute or chronic forms of disease through wall thickness. The value of 3 mm is considered as a cut-off value to distinguish between acute and chronic forms. Additionally, the chronic form has inner smooth margins, whereas, acute form has slight irregular margins. Thick walled cavities are usually associated with hilar or mediastinal nodes, whereas, thin walled cavities comprise of calcified nodes. Similarly, acute form is indicated by small ground-glass haze, whereas, chronic form may be depicted through no change or fibrotic changes. In case of presence of calcified granulomas, healed lesions are indicated.[9]

The present research work was limited in terms of sampling from population of country having PTB as an endemic. Moreover, the sample was

obtained from only one locality. Future research works, should be focused on multi-center approach to get more generalized results.

CONCLUSION

HRCT is useful in depicting the radiological features indicative of presence of tuberculosis. The traditional radiological findings may be discrete in this regard. HRCT is able to show disease progress as well as help in treatment options. It is highly sensitive in assessing active disease. In case of diagnosing pulmonary tuberculosis (PTB), it has got high specificity. The diagnostic accuracy suggests that HRCT has high diagnostic potential for pulmonary tuberculosis (PTB).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Maria Naseer	Data collection, Drafting, Literature search.	
2	Salahuddin Balooch	Drafting, Literature search.	
3	Umar Amin	Drafting, Literature search.	
4	Muhammad Amin	Drafting, Literature search.	
5	Muhammad Usman Khan	Literature search, Statistics.	
6	Madeeha Anwar	Questionnaire, Design, Statistics	