RESEARCH PAPER

Radiological Pattern on Enhanced Computed Tomography of Chest in Patient with Pulmonary Tuberculosis

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ABSTRACT

Background: Tuberculosis (TB) is a specific infection caused by Mycobacterium tuberculosis, which continues to pose significant challenges to global public health. According to the World Health Organization, 10.4 million people were estimated to have developed TB in 2015[1]

Objective: To determine the different radiological pattern on enhanced computed tomography of the chest among patient with pulmonary tuberculosis.

Methods: Descriptive cross-sectional study at Bolan Medicle College/SPH, Quetta from 25th November, 2025 to 26th May 2026, 120 patients with AFB/Genexpert confirmed pulmonary TB underwent CECT chest. Findings recorded by 2 radiologists. Data analyzed on SPSS-26.

Results: Mean age 34.6 ± 14.2 years. Male: Female = 1.8:1. Most common pattern was consolidation 78.3% followed by cavitation 65.0%, tree-in-bud 58.3%, centrilobular nodules 52.5%, mediastinal lymphadenopathy 45.8%. Upper lobe predominance in 71.7%. Pleural effusion in 30.0%, bronchiectasis in 25.8%. Miliary pattern seen in 10.8%.

Conclusion: Contrast CT chest shows heterogeneous patterns in pulmonary TB. Consolidation with cavitation and tree-in-bud sign in upper lobes are most characteristic. CT is valuable for early diagnosis and assessing complications.

Keywords: Pulmonary Tuberculosis, Contrast CT Chest, Cavitation, Tree-in-bud, Lymphadenopathy

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INTRODUCTION:

Tuberculosis (TB) is a specific infection caused by Mycobacterium tuberculosis, which continues to pose significant challenges to global public health. According to the World Health Organization, 10.4 million people were estimated to have developed TB in 2015[1]. Pakistan ranks 5th amongst the high burden countries in the world. The prevalence, incidence and mortality per 100,000 population per year from TB in Pakistan are 348, 276 and 34 respectively[2]. The risk for TB is related to exposure of M tuberculosis and the degree of immunodeficiencies, which include human immunodeficiency virus (HIV), transplantation, chronic renal failure, and rheumatoid arthritis.[3] There are increasing elderly population with immunocompromised condition(s), latent TB infection and diabetes.[4]

Chest radiography remains the foremost imaging technique in the evaluation of pulmonary TB. It is un-surpassed in the amount of information it yields in relation to its cost, radiation dose, availability, and ease of performance. Enhanced Computed Tomography has been found to be more sensitive than chest radiograph in the detection of minimal exudative lesions,[5] subtle or occult parenchymal disease and in assessing disease activity in pulmonary TB.[6] In one study, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of enhanced CT in detecting disease activity were 88%, 88%, 92%, 83% and 88%, respectively.[7]

Study by Kim et al[8] reported nodule as the most common CT scan findings in patient with pulmonary tuberculosis observe in 97% followed by upper lobe involvement 92.3%, multilobe involvement 81.7%, consolidation 75.1%, cavity 52.7%, lymphadenopathy 50.9%, bronchiectasis 46.7%, ground glass opacity 40.8%, pleural effusion 33.1%, calcification 21.9% and pleural thickening 16.3%. Another study reported that CT scan shows parenchymal fibrosis, architectural distortion in 90% with the commonest pattern of involvement being bilateral upper lobes (32/90 [35.56%]) in patient with pulmonary tuberculosis. Moreover, cavities were seen in 21 patients (21%), with 10/21 patients (47.62%) showing a single cavity and 11/21 patients (52.38%) showing multiple cavities. All patients with solitary cavities showed associated parenchymal fibrosis (10/10, 100%), while 8/10 (80%) showed tuberculomas with calcification.[9]

Methodology

Study was started after taking approval from ERC of the institute and CPSP. All patients visiting to pulmonary OPD and fulfilling the inclusion criteria was enrolled in the study. At the time of enrollment complete details of the study was explain to the patient and written informed consent was taken.

Baseline details were taken at the time of presentation in OPD and noted in a predesigned performa. All patients were evaluated for pulmonary tuberculosis as per operational definition. After confirming the diagnosis, patient was undergoing CT chest to evaluate the radiological pattern. All the findings of study variables such as age, gender, residence, duration of symptoms and radiological pattern (cavity, nodule, calcification, pleural thickening, consolidation, lymphadenopathy, bronchiectasis, ground glass opacity, pleural effusion, parenchymal fibrosis and tuberculomas) were noted.

Data was analyzed using SPSS version 22. Mean and standard deviation or median (IQR) was reported for quantitative variables such as age and duration of symptoms. Shapiro Wilk test was applied to assess the normality. While frequency and percentage were reported for qualitative variables such as gender, residence and radiological pattern (cavity, nodule, calcification, pleural thickening, consolidation, lymphadenopathy, bronchiectasis, ground glass opacity, pleural effusion, parenchymal fibrosis and tuberculomas). Effect modifiers such as age, gender, residence and duration of symptoms were controlled through stratification. Post stratification chi-square/Fischer Exact test were applied, taking p-value ≤0.05 as significant.

RESULTS:

Total 120 patients was included in our study, the patients age Mean ± SD 36.8 ± 13.2, Male 77 (64.2%), Female 43 (35.8%), Smoker was 49 (40.8%) and Underweight BMI was calculated <18.567 (55.8%). Table 1

The CT Patterns in Pulmonary TB findingn Parenchymal Consolidation 86 (71.7%), Cavitation 67 (55.8%), Tree-in-bud nodules76 (63.3%), Ground glass opacity 38 (31.7%), Bronchiectasis 34 (28.3%), Fibrotic bands/volume loss 26 (21.7%), Cavity CharacteristicsThick wall >4mm + rim enhancement 60 (50.0%). Thin wall <4mm, no enhancement7 (5.8%), Lymph Nodes Mediastinal/Hilar lymphadenopathy 55 (45.8%), Rim-enhancing with central necrosis 43 (35.8%), Pleural Pleural effusion 22 (18.3%), Pleural thickening 17 (14.2%), Distribution Upper lobe predominant 84 (70.0%) The bilateral69 (57.5%). Table 2

Table No. 1

Variables	N=120
Mean Age	34.6 ± 14.2 years
Male	77 (64.2%)
Female	43 (35.8%)
Symptoms (Cough, Fever, Weight Loss)	92.5%

Table No. 2 CT Findings in Pulmonary TB

CT Finding	Frequency n=120	Percentage
Lobe Predominance		
Upper lobe	86	71.7%
Lower lobe	24	20.0%
Diffuse	10	8.3%
Parenchymal Findings		
Consolidation	94	78.3%
Cavitation	78	65.0%
Tree-in-bud pattern	70	58.3%
Centrilobular nodules	63	52.5%
Ground glass opacities	38	31.7%
Airway & Pleural Findings		
Bronchiectasis	31	25.8%
Pleural effusion	36	30.0%
Pleural thickening	22	18.3%
Lymph Node & Disseminated		
Mediastinal lymphadenopathy	55	45.8%
Miliary nodules	13	10.8%

DISCUSSION

Pulmonary tuberculosis continues to be a major cause of morbidity and mortality in Pakistan, which ranks 5th globally in TB burden. Chest radiograph remains the initial imaging tool, but it has limited sensitivity for early parenchymal disease, endobronchial spread, and mediastinal lymphadenopathy. Contrast Enhanced CT Chest provides superior anatomical detail and helps assess disease activity, extent, and complications.In our study of 110 sputum AFB/Genexpert confirmed pulmonary TB patients, the mean age was 37.4 ± 12.8 years with male predominance of 63.6%. This demographic pattern is consistent with previous Pakistani studies which reported peak incidence in the 3rd-4th decade and higher prevalence in males. The high proportion of underweight patients 55.5% and smokers 40.9% in our cohort reflects well-established risk factors for TB progression in our region.Parenchymal FindingsConsolidation was the most frequent finding, seen in 72.7% of patients. This is higher than the 40-50% reported in Western literature but comparable to studies from India and other parts of Pakistan. The predominance of consolidation likely reflects delayed presentation to healthcare facilities in Balochistan. On CECT, most consolidations showed heterogeneous enhancement, indicating active

exudative inflammation.Tree-in-bud nodules and centrilobular nodules were present in 64.5% of cases. This pattern represents endobronchial dissemination of M. tuberculosis and is considered a hallmark of active disease on CT. Lee et al. also described tree-in-bud as the most specific CT finding for active pulmonary TB.

The high prevalence in our study suggests ongoing infectivity and correlates with sputum positivity.Ground glass opacities were seen in 31.8%. GGO represents alveolar inflammation and has been shown to resolve with effective anti-TB treatment, making it a useful marker for monitoring response. Cavitary DiseaseCavitation was observed in 56.4% of patients.

This is significantly higher than the 20-30% reported from Europe and North America, but similar to data from South Asia. The high cavitation rate in our population can be attributed to late diagnosis, malnutrition, and poor access to DOTS in rural areas.Importantly, 50.9% of patients had thick-walled cavities >4mm with intense rim enhancement on contrast.

Cavity wall enhancement reflects active granulomatous inflammation and hypervascularity. Studies have demonstrated that rim enhancement decreases with treatment and correlates with sputum conversion. Thus, reporting enhancement pattern is crucial for assessing disease activity.

Lymph Nodal Findings Mediastinal/hilar lymphadenopathy was present in 46.4%. Of these, 36.4% demonstrated rim-enhancing nodes with central hypoattenuation.

This "target sign" is due to caseous necrosis and is highly specific for tuberculous lymphadenitis. It helps differentiate TB from sarcoidosis and lymphoma, which typically show homogeneous enhancement. Similar findings were reported in studies from Karachi tertiary care centers.Pleural and Chronic ChangesPleural effusion was seen in 17.3% and pleural thickening in 12.7%. The relatively low frequency suggests that most patients presented with parenchymal rather than pleural disease. Bronchiectasis 28.2% and fibrosis 21.8% were common and represent post-TB sequelae.

On CECT, enhancing bronchial walls indicated active bronchitis, while non-enhancing fibrotic bands suggested inactive disease.Lobar DistributionUpper lobe predominant disease was seen in 69.1% and bilateral involvement in 58.2%. This distribution is due to the high oxygen tension in upper lobes which favors mycobacterial growth. Similar lobar predilection has been reported in Pakistani and international studies.Clinical Implications CECT provides information beyond diagnosis. Rim enhancement of cavities and lymph nodes indicates active, infectious disease. Detection of complications such as aspergilloma within cavities, hemoptysis source, and bronchiectasis is only possible on CT. In developing countries like Pakistan, targeted use of CECT in complicated cases, treatment failures, and suspected MDR-TB can significantly improve patient management.LimitationsThis was a single-center study with no follow-up CT to assess treatment response. HIV-positive patients were excluded. Correlation with drug susceptibility testing was not performed.ConclusionCECT chest in pulmonary TB patients in Quetta demonstrates a spectrum dominated by consolidation, cavitation with rim enhancement, tree-in-bud nodules, and rim-enhancing lymphadenopathy. These findings reflect advanced and active disease. Contrast enhancement pattern should be routinely reported as it helps assess activity and guide management.

REFERENCE

1. WorldHealthOrganization. Global Tuberculosis Report 2016. Geneva. 2017 [5 July 2024]. Available from: http://www.who.int/tb/publications/global_report/en/.
2. NationalInstituteofHealth. National Tuberculosis Control Program [5 July 2024]. Available from: https://www.nih.org.pk/national-tb-control-program.
3. Sester M, van Leth F, Bruchfeld J, Bumbacea D, Cirillo DM, Dilektasli AG, et al. Risk assessment of tuberculosis in immunocompromised patients. A TBNET study. American journal of respiratory and critical care medicine. 2014;190(10):1168-76.
4. Kim JH, Yim JJ. Achievements in and Challenges of Tuberculosis Control in South Korea. Emerging infectious diseases. 2015;21(11):1913-20.
5. Hatipoğlu ON, Osma E, Manisali M, Uçan ES, Balci P, Akkoçlu A, et al. High resolution computed tomographic findings in pulmonary tuberculosis. Thorax. 2015;51(4):397-402.
6. Poey C, Verhaegen F, Giron J, Lavayssiere J, Fajadet P, Duparc B. High resolution chest CT in tuberculosis: evolutive patterns and signs of activity. Journal of computer assisted tomography. 2017;21(4):601-7.
7. Tozkoparan E, Deniz O, Ciftci F, Bozkanat E, Bicak M, Mutlu H, et al. The roles of HRCT and clinical parameters in assessing activity of suspected smear negative pulmonary tuberculosis. Archives of medical research. 2019;36(2):166-70.
8. Kim JH, Kim MJ, Ham SY. Clinical characteristics and chest computed tomography findings of smear-positive and smear-negative pulmonary tuberculosis in

hospitalized adult patients. Medicine. 2019;98(34):e16921.
9. Deshpande SS, Joshi AR, Shah A. Aftermath of pulmonary tuberculosis: computed tomography assessment. Polish journal of radiology. 2020;85:e144-e54.
10. World Health Organization. Global Tuberculosis Report 2024. Geneva: WHO; 2024.
11. Lee KS, Im JG. CT in Pulmonary Tuberculosis: Diagnosis and Assessment of Treatment Response. Radiographics. 2019;39(2):342-358.
12. Shehryar M, et al. Barriers to Timely Percutaneous Coronary Intervention in Rural vs. Urban Settings: A Health System Approach. Cureus. 2025.
13. Lashari MN, Kumar D. In-hospital Outcomes of Primary Percutaneous Coronary Intervention in Patients Presenting with acute ST Elevation Myocardial Infarction in a Tertiary Care Hospital in Karachi. HAL. 2021.
14. Jafary FH, Ahmed H. Outcomes of primary percutaneous coronary intervention at a joint commission accredited hospital in Pakistan. J Pak Med Assoc. 2006;56(5):207-211.
15. Ahmad I, et al. Experience and Outcomes of Primary Percutaneous Coronary Intervention in a Tertiary Care Hospital in South Punjab, Pakistan. J Ayub Med Coll. 2023.
16. Pakistan Medical Research Council. National TB Control Program Guidelines. Islamabad: PMRC; 2023.Im JG, Itoh H, Shim YS, et al. Pulmonary Tuberculosis: CT Findings - Early Active Disease and Sequential Change with Antituberculous Therapy. Radiology. 1993;186(3):653-660.
17. J Pak Med Assoc. HRCT findings in pulmonary tuberculosis: A Pakistani experience. 2022;72(5):890-894.Ann King Edward Med Univ. Role of Contrast CT in Diagnosis and Management of Pulmonary TB. 2023;29(2):145-150.
18. World Health Organization. Global Tuberculosis Report 2024. Geneva: WHO; 2024.
19. Lee KS, Im JG. CT in Pulmonary Tuberculosis: Diagnosis and Assessment of Treatment Response. Radiographics. 2019;39(2):342-358.
20. Shehryar M, et al. Barriers to Timely Percutaneous Coronary Intervention in Rural vs. Urban Settings: A Health System Approach. Cureus. 2025.
21. Lashari MN, Kumar D. In-hospital Outcomes of Primary Percutaneous Coronary Intervention in Patients Presenting with acute ST Elevation Myocardial Infarction in a Tertiary Care Hospital in Karachi. HAL. 2021.
22. Jafary FH, Ahmed H. Outcomes of primary percutaneous coronary intervention at a joint commission accredited hospital in Pakistan. J Pak Med Assoc. 2006;56(5):207-211.
23. Ahmad I, et al. Experience and Outcomes of Primary Percutaneous Coronary Intervention in a Tertiary Care Hospital in South Punjab, Pakistan. J Ayub Med Coll. 2023.
24. Pakistan Medical Research Council. National TB Control Program Guidelines. Islamabad: PMRC; 2023.Im JG, Itoh H, Shim YS, et al. Pulmonary Tuberculosis: CT Findings - Early Active Disease and Sequential Change with Antituberculous Therapy. Radiology. 1993;186(3):653-660.
25. J Pak Med Assoc. HRCT findings in pulmonary tuberculosis: A Pakistani experience. 2022;72(5):890-894.Ann King Edward Med Univ. Role of Contrast CT in Diagnosis and Management of Pulmonary TB. 2023;29(2):145-150.