IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 2 Ser. 2 (February. 2019), PP 81-86
www.iosrjournals.org

Assessment of Diagnostic Efficiency of HRCT Lung with Chest X-Ray Findings in Patients with Pulmonary Tuberculosis

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Introduction-*Tuberculosis is one of India major public health problems. Though it's treatable, but still umpteen number of people are afflicted every year with high morbidity and mortality. Early diagnosis is the essence in the management of pulmonary tuberculosis to prevent further progression of disease and permanent damage by fibrosis.*
The objectives of our study are:
1) To evaluate spectrum of pulmonary abnormalities on HRCT in patients with suspected PTB but with both normal and abnormal chest radiograph.
2) To determine the value of HRCT in predicting disease activity in Pulmonary Tuberculosis.
3) To determine the pattern of HRCT findings in active & inactive Pulmonary Tuberculosis.
Material and method
This prospective study in which data has been collected from 66 suspected patients of pulmonary tuberculosis from August 2015 to November 2016 who were referred to the department of radio diagnosis, GRMC, Gwalior from department of medicine and department of chest TB for evaluation.
Well informed consent was obtained and each suspected patient of pulmonary tuberculosis underwent chest X ray using MARS 50/FC/ALLPOSE, ALLENGER and HRCT using a 128-slice volume scanner (SIEMENS SOMATOM Definition AS+: 95157) and sputum smear examination for AFB. Images were assessed for pattern and distribution of lung abnormalities.
Result: *Male preponderance was noted with majority of them belonging to 50-59 yr of age group.Majority of patients belong to active tuberculosis with a percentage of 57.5%(56+1.5%),next was relapsing tuberculosis.Final diagnosis of active tuberculosis correlates well with sputum examination which was 100% accurate.X RAY chest diagnosed active TB in 22 cases and all were AFB positive on sputum examination.Sputum smear examination is investigation of choice for diagnosis of TB,but the sensitivity is low .HRCT is helpful in differentiating active vs inactive TB better than plain chest radiograph and recognizing extent of pulmonary TB.*
Conclusion: *HRCT can be beneficial in certain cases, imparting crucial information for the diagnosis and management of the disease. HRCT is advocated if tuberculosis is suspected clinically and the chest X-ray findings are normal or inconclusive; for authentication of diagnosis and discernment of activity*
Keywords: HRCT –*high resolution computed tomography*

Date of Submission: 25-01-2019 Date of acceptance: 08-02-2019

I. Introduction:

Tuberculosis is one of India's major public health problems. Though it's treatable, but still umpteen number of people are afflicted every year with high morbidity and mortality; eventuating substantial impact on social and economic development.

India reported approximately 2.8 million of the estimated 10.4 million global incidence of tuberculosis (TB) in 2016 [1] According to WHO estimates, India has the world's largest tuberculosis epidemic. In India, each year, nearly 220, 000 deaths are reported due to Tuberculosis, the pestilential disease which primarily afflicts the pulmonary system, but can also affect various other parts of body like abdomen, brain, skeletal system etc. Transmission is via droplet spread, the most frequent source of infection being the patient with sputum smear positive pulmonary tuberculosis.

Early diagnosis is the essence in the management of pulmonary tuberculosis to prevent further progression of disease and permanent damage by fibrosis. Sputum smear examination for acid fast bacilli is the most widely accepted modality in the diagnostic work up of pulmonary tuberculosis. Chest X-ray is the first line radiological modality of choice for patients coming to hospital with symptoms like productive cough, fever,

weight loss etc, suspicious for tuberculosis. HRCT chest is especially beneficial to detect consolidation, cavitation, tree in bud pattern etc, highly indicative of active tubercular infection.

The **objectives** of our study are:

1) To evaluate spectrum of pulmonary abnormalities on HRCT in patients with suspected PTB but with both normal and abnormal chest radiograph.
2) To determine the value of HRCT in predicting disease activity in Pulmonary Tuberculosis.
3) To determine the pattern of HRCT findings in active & inactive Pulmonary Tuberculosis.

II. Materials and methods:

The present study is a single blind, prospective type in which data has been collected from 66 suspected patients of pulmonary tuberculosis of varying ages between 16 to 75 years and both sexes, who were referred to the department of radio diagnosis, GRMC, Gwalior from department of medicine and department of chest TB for evaluation. The study included cases in the department from August 2015 to November 2016. Well informed consent was obtained and each suspected patient of pulmonary tuberculosis underwent chest X ray using MARS 50/FC/ALLPOSE, ALLENGER and HRCT using a 128-slice volume scanner (SIEMENS SOMATOM Definition AS+: 95157) and sputum smear examination for AFB. The PA view of CXR and HRCT were obtained in all the patients and images were assessed for pattern and distribution of lung abnormalities.

HRCT scans were obtained at end inspiration using 1 mm collimation and 10 mm intervals from the apex of the lung to the diaphragm using 120 kV and 200-300 mAs. Scans were viewed in both the lung window (WW-1500 HU/ WL-700HU) and mediastinal window (WW- 450 HU/WL-20 HU)

Statistical analysis was done by SPSS software. P values were calculated wherever required using chi square test. P value less than 0.05 was considered significant

The study was approved by the hospital ethical committee.

Inclusion criteria

- Patients more than 16 years of age group of both the sexes who presented in the department for suspected tuberculosis.
- Patients with abnormal CXR but inconclusive laboratory/sputum reports.

Exclusion criteria

- Paediatric age group
- Un-cooperative patients who were not able to hold their breath
- Patients who turned out to be neoplastic
- Pregnant females

Interpretation of CT images

CT images were assessed for CT patterns and distribution of lung abnormality. CT patterns included nodular opacities, ground glass opacities (GGO), air space consolidation, cavitation, tree in bud pattern, thickened broncho-vascular bundle, bronchiectasis, emphysematous changes, lymphadenopathy, pleural effusion, fibrosis, calcifications, and volume loss.

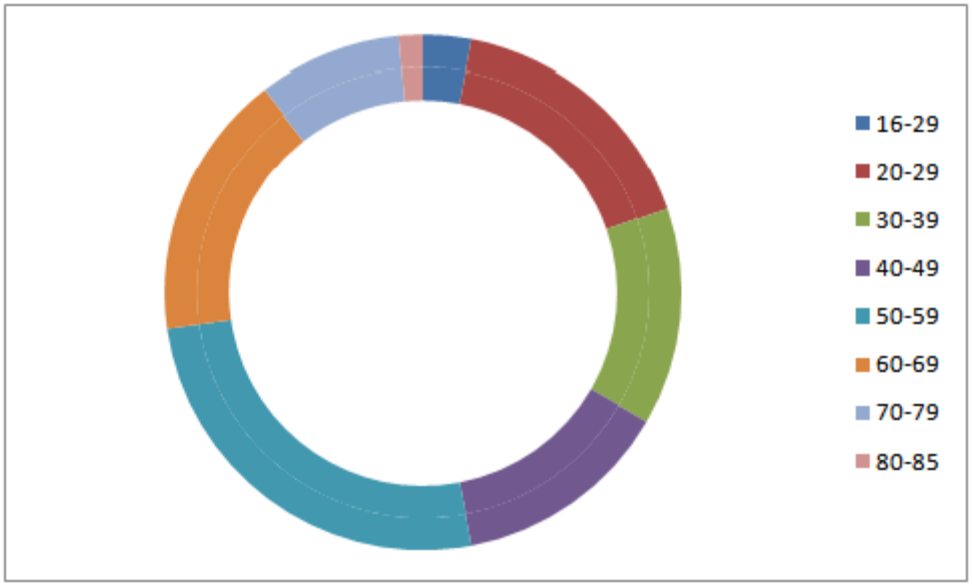
Tuberculosis was postulated in patients with consolidation, nodular opacities especially the tree in bud pattern that is highly suggestive of active endo-bronchial infection. Diagnosis of active pulmonary tuberculosis was based on clinical correlation and positive AFB (acid fast bacillus) in sputum and culture along with changes on serial radiographs observed during treatment. Patchy fibrosis with ectatic changes and calcification were speculated as focus of healed tuberculosis.

Any nodular opacities/ consolidation within the background of healed tuberculosis were put forward as relapsing tuberculosis.

III. Results

OBSERVATIONS AND RESULTS:

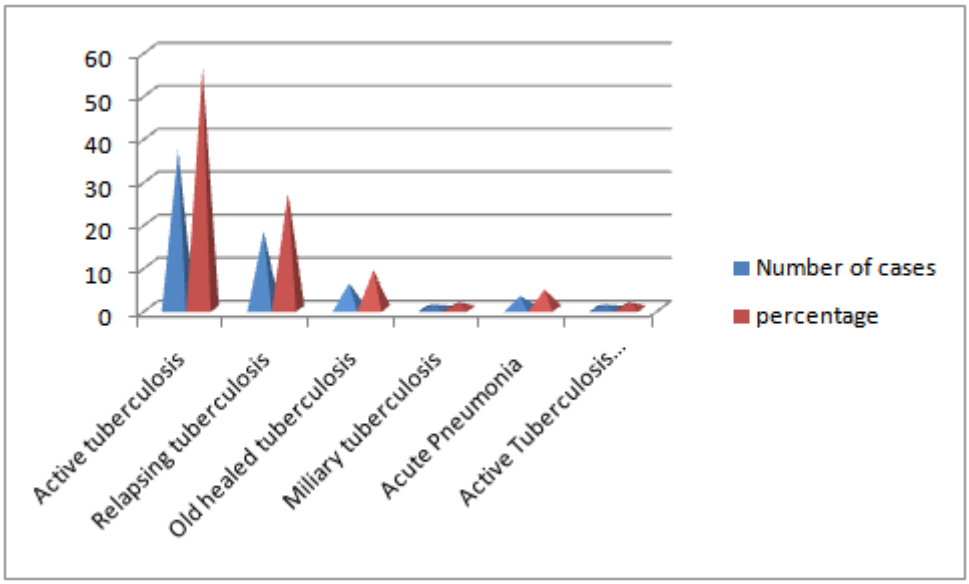
66 cases presenting with fever and cough between August 2015 and November 2016, were evaluated in this study. Observations were made on the basis of chest skiagram and HRCT thorax scans in each patient. Of the 66 cases studies, 44 (66.6%) were males and 22 (33.3%) were females. The youngest patient was 16 years old and eldest patient was 85years old.



Maximum patients (17) were in the age group of 50-59 years
(25.75%) followed by 20-29 years (16.76%) and 60-69years (16.76%) and minimum in the age group of 80-85years (1.52%). Among males, majority fell into the 6th decade (25%) followed by 3rd decade (20.45%) while among females majority were in the 6th decade(9%) followed by 3rd & 4th decade (6%).

Table 2: Distribution of Cases based on final diagnosis on HRCT.

Final diagnosis on HRCT	Number of cases	percentage
Active tuberculosis	37	56
Relapsing tuberculosis	18	27
Old healed tuberculosis	6	9
Miliary tuberculosis	1	1.5
Acute Pneumonia	3	4.5
Active Tuberculosis with Aspergilloma	1	1.5



In our study, majority of the patients belonged to the active tuberculosis group with a percentage of 57.5% (56+1.5%). Next was Relapsing Tuberculosis (27%). Old healed Tuberculosis accounted for 9% of the cases. 1 case had Aspergilloma along with Active Tuberculosis. Three cases had acute pneumonia though findings were similar to tuberculosis.

Table 3: Correlation of final diagnosis on HRCT with laboratory findings

Final diagnosis on HRCT	No.of cases	Sputum +ve for AFB	Sputum for gram +/- organisms
Active tuberculosis	37	37	0
Relapsing tuberculosis	18	12	6
Old healed tuberculosis	6	4	2
Miliary tuberculosis	1	1	0
Acute Pneumonia	3	1	2
Active Tuberculosis with Aspergilloma	1	1	0
TOTAL	66	56	10

Final diagnosis of Active tuberculosis correlated well with sputum examination (100% accurate). Diagnosis of relapsing tuberculosis was confirmed in 12 out of 18 cases (67%). Old healed Tuberculosis was confirmed in 4 out of the 6 cases (67%). Diagnosis of miliary tuberculosis was in 1 case which showed sputum positive for AFB. Bacterial pneumonia was confirmed (by sputum examination) in 2 (66%) out of 3 cases diagnosed as tuberculosis on HRCT.

Table 4: Correlation of final diagnosis on CXR with laboratory findings

Final diagnosis on CXR	No.of cases	Sputum +ve for AFB	Sputum for gram +/- organisms
Active tuberculosis	22	22	0
Miliary tuberculosis	1	1	0
Old healed tuberculosis	9	7	2
Relapsing tuberculosis	3	1	2
COPD	1	1	0
Bilateral prominent Bronchovascular markings	1	1	0
Bronchiectesis	1	1	0
Acute Pneumonia	20	17	3
Normal Chest Skiagram	8	7	1
TOTAL	66	58	8

X-ray chest diagnosed active tuberculosis in 22 cases. 22 out of 22 cases (100%) were AFB positive on sputum microscopy. 2 cases (9%) had Gram positive cocci.7 out of 9 cases (77.8%) diagnosed as Old healed Tuberculosis were AFB positive on sputum microscopy.

17 out of the 20 cases (85%) diagnosed as Acute/Active pneumonia were AFB positive. 3 cases (25%) had Gram positive cocci on sputum microscopy. 7 cases out of 8 (87.5%) reported as normal chest skiagram actually were AFB positive, entailing the need for further investigation.

Table 5:Pattern of Tuberculosis diagnosed on CXR

Pattern	Active TB (22)	Relapsing TB (3)	Old Healed TB (9)	Miliary TB (1)
Nodular	-	-	-	1
Consolidation	14	3	1	-
Cavity	11	-	-	-
Cyst	2	-	-	-
Calcification	-	1	4	-
Volume loss	1	1	2	-
Bronchiectesis	1	1	-	-
Fibrosis	1	1	5	-
Pleural Effusion	1	-	1	-

Table 6: HRCT pattern in Tuberculosis with respect to final diagnosis in HRCT

Pattern	Active TB (37)	Relapsing TB (18)	Old Healed TB (6)	Miliary TB (1)
Reticulo-nodular	21	12	2	1
Tree in bud	10	6	-	-
Cavity	18	10	-	-
Consolidation	22	14	-	-
Collapse	4	3	2	-
Pleural effusion	5	2	-	-
Lymphnodes	19	6	3	1
Bronchiectatic changes	6	15	2	-
Emphysematous changes	7	9	2	-
Fibrosis	4	16	2	-

IV. Discussion

Tuberculosis is the frequent cause of morbidity and mortality in India despite being manageable completely. Sputum smear examination is considered as the pivotal investigation of choice for the diagnosis of tuberculosis. The sensitivity however is low and specimens with a concentration of 10^4 colony forming units/ml are more likely to result in a positive smear, while a negative smear is more likely if the count is lower [2]. In 2006, about 1.4 million cases of tuberculosis were registered for treatment in India; 28.7% of them were new smear negative cases [3]. Many of these smear-negative patients yield positive cultures for M tuberculosis, whereas others remain culture negative. But culture of sputum for acid fast bacilli (AFB) is time consuming and a reliable serological test is not yet available.

In such diagnostic dilemmas, radiological evaluation plays an important role. In a patient with pulmonary tuberculosis, CXR is often the first line modality, often being cheap and easily accessible but limited in scope and sensitivity. This is because minimal exudative tuberculosis can be overlooked on standard chest radiography [4]. High Resolution 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]. Ultrasonography is not useful to diagnose lung lesions but can be helpful in assessing pleural effusion and findings of abdominal tuberculosis like lymphadenopathy, ascites etc. [7]

HRCT is also helpful in differentiating active vs inactive TB and is better than plain chest radiograph in recognizing the extent of pulmonary TB, especially subtle areas of consolidation, cavitation, centrilobular nodules (tree in bud pattern), bronchogenic and miliary spread. HRCT is recommended when the radiographic findings are normal or inconclusive and tuberculosis is suspected clinically for the confirmation of diagnosis and determination of activity.[8]. In a study of patients with sputum positive tuberculosis by Raniga and colleagues, 92% had HRCT findings of bronchogenic spread of the disease and 4% had miliary tuberculosis. Centrilobular nodule with branching linear structure/'tree-in-bud' appearance was seen in 80%, cavitation in 64%, consolidation in 52% and poorly defined nodule in 40% cases in this study [8]

A study by Ghosh et al delineated that the centrilobular pattern was found in 19 patients out of 50 (38 % of cases) , cavitation in 34 % cases, ground glass in 24 % cases , military pattern in 12 % cases, tree-in -bud in 24 % cases. Others lesion like mediastinal lymph nodes in 14 % and pulmonary calci□cation in 18 % of the cases were noted. [9].Hussain et al suggested as centrilobular nodules being the most common finding in their study [10].

In our study, HRCT findings of AFB positive tuberculosis cases were mostly comparable to the above-mentioned studies. Centrilobular nodules with tree in bud pattern were most commonly observed in active tuberculosis in 31 out of 37 cases (83.7%). Cavitation was observed in 28 cases of active and relapsing tuberculosis in comparison to 11 cases on chest X-ray. Consolidation was reported in 36 cases on HRCT in comparison to 18 cases on CXR. Our study also depicted that there is probability of missing tuberculosis on chest X-ray and HRCT should be included as a modality to diagnose tree in bud pattern with centrilobular nodules, cavitation and consolidation in cases of active tuberculosis. In our study pattern of tuberculosis on chest X-ray correlated with $\chi^2 = 56.75$ and p value of 0.0001 and on HRCT as p value of 0.01 with $\chi^2 = 32.92$; both of which are considered significant.

India, as a developing country must work on major causative factors of TB, especially poverty, under-nutrition and tobacco smoking; analyzing the major gaps that have already been identified like dearth of proper diagnosis or initiation of treatment and counseling of defaulters. In order to ameliorate this system, India needs to expedite its resources for both pathological and radiological diagnosis of tuberculosis along with its management. [11]

Limitations

Sample size is less and we could not assess lymphadenopathy exactly as the study was non- contrast.

V. Conclusion

Although chest radiography remains the prime imaging technique in the assessment of pulmonary TB, HRCT can be beneficial in certain cases, imparting crucial information for the diagnosis and management of the disease. HRCT aids in differentiating active from inactive TB. Centrilobular nodules with "Tree in bud" appearance- suggestive of endobronchial spread and hence active disease was the most frequent and characteristic findings on HRCT scan obtained in patients in our study population. These findings are not encountered commonly on chest radiographs, and HRCT is specifically sensitive in detecting this finding. HRCT is effective in delineating even the small patch of consolidation and parenchymal cavitation. Areas of fibro- ectatic and calcific disease along with distortion of the underlying lung parenchyma, suggesting the extent of pulmonary tuberculosis are recognized better than plain chest radiograph on HRCT. HRCT is advocated if tuberculosis is suspected clinically and the chest X-ray findings are normal or inconclusive; for authentication of diagnosis and discernment of activity.

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