DOI: 10.14260/jemds/2015/722

ORIGINAL ARTICLE

COMPUTED TOMOGRAPHIC EVALUATION OF PULMONARY TUBERCULOSIS AND ITS SEQUELAE

Anshuman Anand[1], Md. Nazrul Haque[2], Kashif Shahnawaz[3]

HOW TO CITE THIS ARTICLE:
Anshuman Anand, Md. Nazrul Haque, Kashif Shahnawaz. "Computed Tomographic Evaluation of Pulmonary Tuberculosis and its Sequelae". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 29, April 09; Page: 4948-4955, DOI: 10.14260/jemds/2015/722

ABSTRACT: INTRODUCTION: Tuberculosis is a specific granulomatous disease, caused by mycobacterium tuberculosis. CT scan, particularly HRCT seems to be most useful imaging modality for tuberculous infection and its sequelae. CT is much more sensitive in identifying complications of tuberculosis than any other imaging modality. **MATERIALS & METHODS:** A total of ninety cases of pulmonary tuberculosis were included in the present study. A detailed history, clinical examination and routine laboratory examinations of all the cases were carried out for the confirmation of tuberculosis. All the cases had chest radiography postero-anterior view in erect position using 1000 mA digital X-ray machine of Shimadzu. In all the cases CT examination were performed using Siemens Somatom ARSP – a third generation spiral scanner, within a week of starting antituberculous therapy. **OBSERVATION:** The CT findings were divided into four groups, based on predominant pattern of involvement. These groups are- predominant parenchymal excluding military (57 cases), predominant miliary parenchymal (15 cases), plural effusion (9 cases), and mediastinal lymphadenopathy (9 cases). The predominant parenchymal lesions further consisted of three major patterns. These are nodular opacities (57 cases), confluent consolidation (21 cases) and consolidation with associated loss of volume (36 cases). **CONCLUSION:** CT showed three major patterns of parenchymal lesions. The nodular opacity pattern suggesting bronchogenic spread. Cavitations were most common with consolidation with associated loss of volume, lesions suggesting liquifactive necrosis of caseous focus.

KEYWORDS: Computed Tomography, Tuberculosis, Evaluation.

INTRODUCTION: Tuberculosis is an airborne infectious disease caused by Mycobacterium tuberculosis and is a major cause of morbidity and mortality, particularly in developing countries.[1-3] It primarily affects lungs and causes pulmonary tuberculosis. With the higher incidence of multidrug resistant tuberculosis in HIV-positive patients, tuberculosis is no longer a problem of third world only rather it has become a global problem.[4]

The conventional chest radiograph is a simple and economical investigative tool for the diagnosis and follow-up of chest tuberculosis. Sometimes the disease may go undetected or the results are equivocal. Particularly the activity of post primary disease cannot be accurately assessed by chest radiography. Frequency of false negative examination is 1% in adult immunocompetent population and increases to 7-15% in HIV seropositive individuals. The bacteriological analysis of sputum is although highly specific, but not very much sensitive and dependent on the technique of sample collection and culture. Unfortunately, acid fast bacilli are found in the sputum in a limited number of patients with active pulmonary tuberculosis.[5] Biopsy of lesion is invasive and that also requires some kinds of guidance.

DOI: 10.14260/jemds/2015/722

CT Scan with/without contrast particularly HRCT seems to be most useful imaging modality for tuberculous infection of lung and their sequelae. CT displays overlapping structures in cross section format and so can detect small lesions and it also provides better contrast resolution. CT is capable of depicting the entire dynamic range of radio-densities like lung parenchyma, soft tissue, blood density, bone density and metallic densities in a single exposure. In addition to increased sensitivity in detecting parenchymal lesions, pleural, pericardial disease and hilar/mediastinal lymphadenopathy can be well documented and characterized by CT.[6] Although no imaging modality can predict activity accurately, predictivity of activity is more in CT particularly HRCT, than any other imaging modality. CT is much more sensitive in identifying complications of tuberculosis than any other imaging modality.[7] Complications like bronchiectasis, intracavitary fungal ball, constrictive pericarditis, empyema necessitans and rib involvement can be well picked up. CT can also help in selecting appropriate procedure and optimal site of biopsy in diagnostically problematic cases and mimicking lesions like bronchogenic carcinoma. CT is indicated in the following settings:

1. In the evaluation of the any patient suspected of having occult tuberculosis.
2. In the evaluation of any patient in whom the diagnosis of tuberculosis is indicated but the radiographs are equivocal and clinical presentation and history are indeterminate.
3. In any patient known to have tuberculosis in whom tuberculosis may have developed and chest radiographs are equivocal.
4. In any patient known to have tuberculosis, when another disease such as neoplasia is suspected and routine chest radiography is unable to evaluate because of extensive disease.

The present study was carried out with the following Objectives:

1. To describe the spectrum of radiological changes seen in the chest by computed tomography in patients with pulmonary tuberculosis.
2. To analyze the sequelae of pulmonary tuberculosis.
3. To describe the radiological manifestations seen in the chest by computed tomography in HIV positive patient having pulmonary tuberculosis.
4. To review previous literature in the same field and comparing the results.

MATERIALS AND METHODS: The present study was a cross-sectional study, carried out in M. G. M Medical College and L. S. K Hospital, Kishanganj, Bihar. Institutional ethical committee approval was taken. Study period was from August-2014 to January-2015 (six months). Privacy of the patients was maintained and consent were also taken from them. A total of ninety cases of pulmonary tuberculosis were selected for the present study. A detailed history was taken from all of them. Then they were subjected to thorough clinical examination and routine laboratory examination. Confirmation of tuberculosis was done by:

1. Either bacteriological confirmation of acid fast bacilli in sputum or a significant skin reaction to purified protein derivative of tuberculo-protein (Mantoux-test) or both and/or radiographic evidence of current disease. ELISA for tuberculous antigen was done in equivocal cases.
2. Clinical and radiological improvement after administration of antituberculous therapy.
3. Diagnosis of tuberculous effusion was done by biochemical and cytological evaluation of aspirated pleural effusion.

DOI: 10.14260/jemds/2015/722

For the confirmation of HIV infection Western Blot test was done. Cases that could not be followed up or no definite diagnosis could be obtained were excluded.

RADIOGRAPHY: All the cases had chest radiography postero-anterior view in erect position using 1000mA digital x-ray machine of Shimadzu.

COMPUTED TOMOGRAPHY: In all cases CT examination were performed using Siemens Somatom ARSP - a third generation spiral Scanner with Somaris software or Somatom sprit dual slice CT scan, within a week of starting antituberculous therapy. After topogram 10 mm contiguous slices were taken from apices to lung bases. Post contrast study with the same scanning parameters were performed, after administration of iopamidol or iohexol 1 -2mg/kg of body weight.

In regions of special interest HRCT was performed using 1 mm slice thickness and High Kernel B80 for high spatial resolution. All the sections were viewed in soft tissue (Mediastinal window), lung window and in special circumstances bone window.

STATISTICAL ANALYSIS: The radiological features were tabulated and expressed as percentage.

OBSERVATION: Ninety patients with pulmonary tuberculosis who presented to M. G. M Medical College & L. S. K Hospital, Kishanganj were included in the present study.

Chief Complaints	Number of cases	Percentage (%)
Fever	57	63.33
Cough	51	56.66
Haemoptysis	21	23.33
Breathlessness	6	6.66
Weight loss	6	6.66
Chest Pain	3	3.33

Table 1

Chief Complaints of patients: Fever and cough were the chief complaints seen in 63.33% and 56.66% cases respectively. Haemoptysis was the complaint in 21 cases (23.33%). Breathlessness and Weight loss was the presenting complain in 6 cases (6. 66%) each. Chest pain was the least common presenting feature accounting for only three cases (33.33%) [Table 1].

LABORATORY FINDINGS: Eighteen cases showed positive staining for acid fast bacilli in sputum. Mantoux test was done in 51 cases. 39 cases showed induration of 10-15 mm (positive) while 12 cases showed strongly positive reaction as evidenced by induration of more than 15 mm.

Findings	Number of cases	Percentage (%)
Consolidation	36	40
Fibronodular changes	9	10
Fibrocavitary changes	21	23.33
Acinar nodules	21	23.33

DOI: 10.14260/jemds/2015/722

Cavities	33	36.66
Lobar collapse	3	3.33
miliary mottling	15	11.66
Pleural thickening	18	20.00
Pleural effusion	12	13.33
Mediastinal lymphadenopathy	18	20.00

Table 2

Findings on chest radiographs (n=90): The most common finding on chest was of consolidation that may be patchy or confluent or segmental, observed in 40% of cases. Fibrocavitary changes and acinar nodules suggesting bronchogenic dissemination were seen in 23.33% of cases each. Cavities which also included fibrocavitary changes was observed in 36.66%. Fibronodular changes accounted for 10% of cases. Lobar collapse was uncommon in this study accounted for only 3.33% of cases. Pleural thickening, and mediastinal lymphadenopathy were seen in 20% of cases. Pleural effusion was seen in 13.33% of cases [Table 2].

Computed Tomographic Findings: The CT findings were divided into four groups based on predominant pattern of involvement [Table 3].

Major Groups	Number of cases
Predominant Parenchymal excluding military	57
Predominant Miliary Parenchymal	15
Pleural effusion	9
Mediastinal lymphadenopathy	9

Table 3

Pulmonary tuberculosis- Major groups.

Pattern	Number of cases	Percentage (%)
Nodular opacities	57	100
Confluent consolidation	21	36.84
Consolidation with associated loss of volume (CWALV)	36	63.16

Table 4

Parenchymal patterns- Frequency of occurrence.

The predominant parenchymal lesions consisted of 3 major patterns. The 'nodular pattern' lesion were composed of multiple small nodules, usually of varying sizes ranging from <5mm to 5-10mm most often. The pattern of 'confluent consolidation' appeared as homogenous or non-homogenous areas of consolidation while the pattern of ‘consolidation with associated loss of volume' (CWALV) appeared as areas of consolidation with apparent focal loss of volume manifesting

DOI: 10.14260/jemds/2015/722

as bronchovascular distortion with or without associated fibrous bands in the adjacent parenchyma. Of the three parenchymal patterns, nodular opacities were seen in all the 57 cases. The pattern of CWALV (Consolidation with associated loss of volume) was noted in 36 patients (63.16%). The 'confluent consolidation' was seen in 21 cases (36.84%). Six of these 21 patients also showed consolidation with associated loss of volume.

DISCUSSION: Based on the findings of chest radiograph and subsequent CT findings the 90 patients were segregated into four groups, for the purpose of analysis and discussion, but the main concern of our study is only the first group, i. e., 57 cases, having predominant parenchymal lesions.

1. Predominant parenchymal (excluding military) - 57 cases.
2. Predominant miliary- 15 cases.
3. 3. Pleural effusion- 9 cases.
4. Mediastinal lymph adenopathy- 9 cases.

PREDOMINANT PARENCHYMAL PATTERNS (EXCLUDING MILIARY): All the important lesions could be categorized into one of the three parenchymal patterns earlier described by Ikezoe et al[8] and Aribandi M et al[9] -namely the 'nodular opacities', 'confluent consolidation' and 'consolidation with associated loss of volume' (CWALV). In our present study the most commonly occurred pattern was the 'nodular opacity' pattern, being seen in 100% cases. The pattern of CWALV was seen in 63.16% while 'confluent consolidation' was seen in 36.84% [Table 4]. Our present study is consistent with the study of Aribandi M et al.[9] They found that nodular opacity was seen in all, confluent consolidation was seen in 37% and CWALV was seen in 69%.

PATTERN I NODULAR OPACITIES: The nodular pattern was the most common of all the three patterns - seen in all the 57 cases (100%). Lesions were usually composed of multiple small nodules, usually of varying sizes (<5 mm and 5-10 mm most often) and suggest bronchogenic spread.

Bronchogenic dissemination was the most common means of spread in the post primary type of tuberculosis. Prerequisite for bronchogenic spread are, necrosis of bronchial wall and softening or liquefaction of the caseous material, which in most lesions is otherwise so viscous that flow into the brochial lumen would seem unlikely.[10] Endobronchial spread of tuberculosis has been described as occurring in 20% of patients with post primary tuberculosis seen in chest radiographs.[11] However, in this study all the patients with predominant parenchymal lesions showed bronchogenic spread. In contrast the chest radiograph showed evidence of bronchogenic spread only in 23.33% of cases (Table-2). Im JG et al[12] also reported similar high incidence of bronchogenic dissemination in HRCT (98%). Raniga S et al[13] reported evidence of bronchogenic spread in 92% of patient on HRCT. In the present study both conventional CT and HRCT showed bronchogenic spread in all the cases.

The nodular pattern lesions were mostly multiple in any given cases. The right side was slightly more often involved than the left (126 verses 102). While a more or less involvement was noted in all the five segmental zones on right side; on left side, lesions were more often seen in the apicoposterior segment of the upper lobe and superior and basal segments of lower lobe.

PATTERN II - CONFLUENT CONSOLIDATION: The pattern of 'confluent consolidation' was noted in 21 out of 57 patients (36.84%). The lesions appeared as homogenous or non-homogenous areas of

consolidation, and could represent confluence and progression of multiple opacities or/of lobular consolidation.[14] All the lesions showed associated satellite lesions. These lesions were distributed equally on both sides. A preponderance of apicoposterior lesion was noted.

All the lesions were confined to within a segment. No non-segmental lesions (i. e., lesions extending through more than one segment contiguously) were found in the present study.

PATTERN III - CONSOLIDATION WITH ASSOCIATED LOSS OF VOLUME: The CWALV lesions appear as areas of consolidation with apparent focal loss of volume manifesting as bronchovascular distortion with or without associated fibrous bands on the adjacent lung parenchyma. These lesions could represent a more advanced stage of the 'confluent consolidation' lesions. 36 of the 57 patients (63.16%) in the present study showed CWALV lesions. The lesions were confined to a single segment. None of the lesions involved adjacent segment as well. The right lung was more often involved than the left (42 verses 33). Again the apico-posterior segment was the most commonly involved segment. Lower lobe segment accounted for only 28%. In six cases there was complete lobar involvement.

Ikezoe et al[8] in 1993 retrospectively analyzed the spectrum of CT findings in 110 patients with active pulmonary tuberculosis. The authors compared the patterns and distribution of findings in diabetic/ immunocompromised patients (39 cases) with those patients without underlying disease (71). The CT was classified into three main patterns. (1) Nodular opacities which included acinar, lobular or patchy lesions, (2) Confluent consolidation, (3) Consolidation with associated loss of volume. 44 (62%) of the 71 patients with no underlying disease had a nodular pattern, 11 (15%) had confluent consolidation, 13 (18%) had consolidation with associated loss of volume and 3 (4%) patients had miliary pattern. Except with those with miliary tuberculosis, almost all the patients (97%) had segmental distribution of lesions. The lesions were confined to a single segment in 21 patients, multiple segments of a single lung in 21 patients and multiple segments of both lungs in 24 cases. Of the 71 cases 22 had the cavitary lesions, the lesions could be single or multiple and a given lesion that cavitate contains only one cavity. Satellite lesions such as small nodular lesions or slightly increased attenuating surrounding the main lesion were found in 63 (93%) of 68 patients who had main CT pattern of parenchymal abnormalities. Comparatively CT pattern seen in diabetic and immunocompromised patients were essentially similar to those seen in patients without an underlying disease. However, the prevalence of nodular pattern was low (38%). Diabetic and immunocompromised patients had high prevalence of nonsegmental distribution (30%) and multiple small cavities within any given lesion (44%). Unusual localization of tuberculosis, including disease confined to the basal segments of the lower lobes, anterior segment of upper lobe and right middle lobe, occurred equally in both groups. Aribandi M et al[9] in 1997 studied 25 patients of active pulmonary tuberculosis. On CT, nodular opacity were seen in all, while confluent consolidation were seen in 37% and CWALV in 69% of patient. Sahoo K et al[15] concluded that HRCT may be helpful in the diagnosis of pulmonary tuberculosis and may be useful in the assessment of the efficacy of anti-tuberculous treatment

Jaiswal A et al[16] concluded that even in sputum smear-negative setting, HRCT can predict the risk of pulmonary tuberculosis with good reproducibility and can select patients having a high probability of pulmonary tuberculosis.

CONCLUSION: Being treatable but a serious health care problem and its magnitude of burden on healthcare services has leaded the undertaking of the present study. To conclude, CT showed three

major patterns of parenchymal lesions - the nodular opacities, confluent consolidation and consolidation with associated loss of volume (CWALV). The nodular opacities pattern suggesting bronchogenic spread and initial stage of the pathological process were seen in all the cases with predominant parenchymal involvement and both lungs were equally involved. The HRCT finding of bronchogenic spread was evidenced by centrilobular/ branching linear structures, bronchial wall thickening, tree in bud appearance and poorly marginated 5-8 mm nodules. The patterns of confluent consolidation and consolidation with associated loss of volume (CWALV) lesions were seen more commonly in the apicoposterior segment and denote advanced stages of nodular opacity. Most of the patterns showed satellite lesions in the form of small nodules or peripheral areas of increased attenuation. Cavitations were most common with CWALV lesions suggesting liquifactive necrosis of caseous focus and its removal at more advanced stages of pathological process.

REFERENCES:

1. Cegielski J P, Chin D P, Espinal M A, et al. The global tuberculosis situation: Progress and problems in the 20th century, prospects for the 21st century. Infect Dis Clin North Am, 2002; 16: 1-58.
2. Corbett E L, Watt C J, Walker N, et al. The growing burden of tuberculosis: global trends and interactions with HIV epidemic. Arch Intern Med, 2003; 163: 1009-1021.
3. Tufariello J M, Chan J, Flynn J L: Latent tuberculosis: mechanisms of host and bacillus that contribute to persistent infection. Lancet Infect Dis, 2003; 3: 578-590.
4. Frieden T R, Sterling T, Pablos-Mendez A, Kilburn J O, Cauthen G M, Dooley S W. The emergence of drug resistant tuberculosis in New York city, N Engl J Med, 1993; 328: 521-526.
5. Lees K S, Im J G. CT in adults with tuberculosis of the chest: characteristic findings and role in management. AJR, 1995; 164: 1361-1367.
6. Mc Guiness G, Naidich D P, Jagirdar J, Leitman B, Mc Cauley D I. High resolution CT findings in miliary lung disease. J Comput Assist Tomogr, 1992; 16: 384-390.
7. Hulnick D H, Naidich D P, Mc Cauley D I: Pleural tuberculosis evaluated by computed tomography, Radiology 1983; 149: 759-765.
8. Ikejoe, Takeuchi N, Johkoh T et al: CT appearance of pulmonary tuberculosis in diabetic and immunocompromised patients who had no underlying disease. AJR, 1992; 159: 1175-1179.
9. Aribandi M et al. Australas Radiology, 1997; 41 (4): 367-70.
10. Pratt P C: Pathology of tuberculosis. Semin Roentgenol, 1970; 14: 196-203.
11. Woo Kung Moon, Im J G et al: Mediastinal tuberculosis: CT findings of active and inactive disease. AJR, 1998; 170: 715-718.
12. Im J G, Itoh H, Shim Y S, et al: Pulmonary tuberculosis: CT findings of early active disease and sequential change with anti tuberculous therapy. Radiology, 1993; 186: 653-660.
13. Raniga S, Parikh N et al: Is HRCT reliable in determining disease activity in pulmonary tuberculosis. Ind J Radiol Imag, 2006; 16 (2): 221-228.
14. Naidich D P, Mc Cauley D J et al: CT of pulmonary tuberculosis. In: Siegelmann S. S ed: Computed tomography of the chest. New York Churchill Livingstone Inc, 1984: 175-217.
15. Sahoo K, Panda B N, Singh V P, Kiran K G, Raha B, Bhalla J S: Bronchogenic evaluation of radiologic sequelae of pulmonary tuberculosis after short term chemotherapy. Ind Jour Tuber, 1988; 35: 128-132.

DOI: 10.14260/jemds/2015/722

16. Jaiswal A, Khanna S P, Menon MPS: Computed tomography features of tuberculous mediastinal lymphadenopathy. Ind Jour Tub, 1992; 36: 229.

AUTHORS:

1. Anshuman Anand
2. Md. Nazrul Haque
3. Kashif Shahnawaz

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radiodiagnosis, MGM Medical College & LSK Hospital, Kishanganj, Bihar.
2. Consultant, Department of Radiodiagnosis, Reddy Healthcare, Siliguri, West Bengal.
3. Assistant Professor, Department of Community Medicine, MGM Medical College, Kishanganj, Bihar.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Kashif Shahnawaz,
Manhar Road, Chhoti Quazipura,
Darbhanga-846004, Bihar.
E-mail: kashif.shahnawaz98@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None

Date of Submission: 15/03/2015.
Date of Peer Review: 16/03/2015.
Date of Acceptance: 26/03/2015.
Date of Publishing: 07/04/2015.