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EVALUATION OF IMAGING FEATURE OF DRUG-SENSITIVE AND RESISTANT PULMONARY TUBERCULOSIS

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ABSTRACT

Background: Assessment of computed tomography signs for suspected resistance identified in subjects with TB and performing timely drug-sensitivity testing in the laboratory could effectively shorten the diagnosis time for drug-resistant tuberculosis and make the early availability of the treatment along with treatment modifications in time to increase the therapeutic efficacy.

Aim: To evaluate the imaging features in drug-sensitive and resistant pulmonary tuberculosis.

Methods: The present study assessed 252 subjects from both genders where 52 subjects had drug-resistant tuberculosis and 250 subjects had drug-sensitive tuberculosis. In all the subjects CT findings were assessed and compared for results formulation.

Results: Non-significant difference was seen in drug-sensitive and drug-resistant tuberculosis for a cavity with intermediate wall thickness, single cavity, consolidation, fibrosis, nodular infiltration, bronchiectasis, miliary pattern, pleural thickening, and pleural calcification with p=1.00, 0.614, 0.358, 0.186, 0.665, 0.086, 0.808, 0.578, and 0.469 respectively. Significantly higher multiple cavities were seen in 81% (n=42) subjects with p=0.001. Cavitary consolidation, thick-walled cavity, atelectasis, pleural effusion, and lymphadenopathy were significantly higher in subjects with drug-resistant tuberculosis with p=0.001, 0.001, 0.032, 0.015, and 0.001 respectively.

Conclusions: The present study concludes that several cavities, particularly those with thick walls, in practically all lobes, notably the higher lobes, are highly suggestive of DR-TB.

Keywords: Drug-sensitive, drug-resistant, pulmonary tuberculosis, tuberculosis.

INTRODUCTION

(DR-TB) Drug-resistant tuberculosis is a clinical condition where tuberculosis is caused by drug-resistant MTB (Mycobacterium tuberculosis).[1] The rapid propagation and emergence of drug-resistant tuberculosis strains, particularly MDR-TB (multidrug-resistant tuberculosis) and XDR-TB (extensively drug-resistant- tuberculosis) resulted in the prolongation of the treatment cycle for tuberculosis to a very high extent and is linked to high cost and non-satisfying-clinical-treatment effects. In the present scenario, the management of drug-resistant tuberculosis is one of the greatest challenges for treating personnel.[2,3]

The early diagnosis and management of drug-resistant tuberculosis is a vital aspect in preventing and minimizing the propagation and epidemic of drug-resistant tuberculosis. Presently, the gold standard and most common approaches for clinical assessment of mycobacterium tuberculosis resistance are DST (drug sensitivity testing) and mycobacterium tuberculosis culture.[4] However, both of these techniques are time-consuming and are usually performed after the failure of the empirical therapy making a large number of subjects with drug-resistant tuberculosis not get a timely diagnosis and effective management.[5,6]

In subjects with pulmonary tuberculosis, chest CT (computed tomography) is the main method for definitive diagnosis along with assessment of follow-ups and therapeutic efficacy assessment for pulmonary tuberculosis.[7] If computed tomography signs for suspected resistance can be identified in subjects with mycobacterium tuberculosis infection, and thus, performing timely drug-sensitivity testing in the laboratory. This could effectively shorten the diagnosis time for drug-resistant tuberculosis and make the early availability of the treatment along with treatment modifications in time to increase the therapeutic efficacy.[8]

The present study assessed subjects with drug-sensitive pulmonary tuberculosis (DS-PTB) and drug-resistant pulmonary tuberculosis (DR-PTB). The study also aimed to improve tactics for combating medication resistance in tuberculosis by increasing our awareness of the benefits and drawbacks of imaging modalities used in TB therapy.

MATERIALS AND METHODS

The present study assessed subjects with drug-sensitive pulmonary tuberculosis (DS-PTB) and drug-resistant pulmonary tuberculosis (DR-PTB). The study also aimed to improve tactics for combating medication resistance in tuberculosis by increasing our awareness of the benefits and drawbacks of imaging modalities used in TB therapy. The study was done at Department of Radiodiagnosis and Respiratory medicine, Sikkim Manipal Institute of Medical Sciences, Gangtok, Sikkim from July 2019 through June 2020 after the clearance was taken from the Institutional Ethical Committee. Verbal and written informed consent was taken from all the subjects before study participation.

The present study assessed 252 subjects from both genders where 52 subjects had drug-resistant tuberculosis and 250 subjects had drug-sensitive tuberculosis assessed by drug sensitivity testing in the laboratory. The study included subjects with a confirmed diagnosis of tuberculosis and subjects who were willing to participate in the study. The exclusion criteria for the study

were subjects with concomitant drug therapy that might affect the results of sensitivity testing, subjects with terminally ill diseases, and subjects who did not give consent for study participation.

After final inclusion, detailed history was taken for all the subjects followed by a comprehensive clinical examination. All the subjects then underwent a high-resolution chest CT (computed tomography) scan using a Philips, Ingenuity Multi-slice (64 slices) CT. With a collimation of 0.625 mm, serial axial thin sections of the chest were taken from around 2 cm superior to the lung apices to the upper abdomen, including the adrenals. Two-millimeter-thick slices were used in the reconstruction, with a one-millimeter gap between slices. Images in axial, coronal, and sagittal projections were studied. Images were analyzed as needed using minimum and maximum intensity projections and volume rendering methods.

Images of lung structure and disease were seen in exquisite detail on a high-resolution CT (HRCT) of the chest. Thin-section CT images were rebuilt using a high-spatial-frequency algorithm in HRCT. Single breath-hold volumetric capture was used retrospectively for HRCT picture reconstruction with MDCT.

“Single cavities, multiple cavities, cavity wall thickness, cavitary consolidation, consolidation, fibrosis, atelectasis, bronchiectasis, lymphadenopathy, pleural effusion, pleural thickening, and pleural calcification were all analyzed and recorded. There were three distinct thickness ranges for the cavities: thin (3mm), medium (3-5mm), and thick (>5mm).”

The data gathered were analyzed statistically using SPSS (Statistical Package for the Social Sciences) software version 16.0 (SPSS Inc., Chicago, USA) for assessment of descriptive measures and the Chi-square test. The results were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered statistically significant.

RESULTS

The present study assessed subjects with drug-sensitive pulmonary tuberculosis (DS-PTB) and drug-resistant pulmonary tuberculosis (DR-PTB). The study also aimed to improve tactics for combating medication resistance in tuberculosis by increasing our awareness of the benefits and drawbacks of imaging modalities used in TB therapy. The present study assessed 252 subjects from both genders where 52 subjects had drug-resistant tuberculosis and 250 subjects had drug-sensitive tuberculosis. There were 66% (n=132) males and 34% (n=68) females in the drug-sensitive tuberculosis group and 90.38% (n=47) males and 9.61% (n=5) females in the multi-drug resistant tuberculosis group (Table 1).

For ATT (anti-tubercular treatment) intake in drug-sensitive and drug-resistant tuberculosis subjects, ATT was taken by 75% (n=39) subjects with drug-resistant tuberculosis and by 30.5% (n=61) subjects with drug-sensitive tuberculosis which was significantly higher in subjects with drug-resistant tuberculosis with p=0.001 and OR (Odd’s ratio of 6.8 (Table 2).

Concerning the distribution of single and multiple cavities in two study groups, the single cavity was seen in 29% (n=15) subjects with drug-resistant tuberculosis and 32% (n=65) subjects with

drug-sensitive tuberculosis. Multiple cavities were significantly higher in 81% (n=42) subjects with drug-resistant tuberculosis and in 37.5% (n=75) subjects with drug-sensitive tuberculosis with p=0.001 and OR=7 (Table 3).

On assessing the distribution of different cavity walls in the study subjects, intermediate wall thickness was seen in 25% (n=13) and 25% (n=50) subjects from DS-TB and DR-TB groups showing statistical non-significance with p=1.00. The thin-wall cavity was seen in 36.53% (n=19) subjects from DR-TB and 12% (n=24) subjects from DS-TB showing statistical non-significance with p>0.05. Thick-walled cavities on CT were seen in significantly higher subjects with DR-TB in 71% (n=37) compared to 44% (n=88) subjects from DS-TB with p=0.001 as shown in Table 4.

The study results showed that for various CT imaging characteristics in study subjects with drug-sensitive and drug-resistant tuberculosis, consolidation was seen in a significantly higher proportion of subjects with drug-resistant TB compared to DS-TB with p=0.001. Fibrosis dispersion showed a non-significant difference in DR-TB and DS-TB groups with p=0.186. Incidence of atelectasis was significantly higher in subjects with DR-TB with 17% (n=9) subjects compared to the DS-TB group with 7.5% (n=15) subjects with p=0.032. Bronchiectasis was comparable in DR-TB and DS-TB groups with p=0.086. The military pattern of tuberculosis was rare. We found just 5 instances of miliary TB within our research population, and all of them were drug-sensitive. Lymphadenopathy and pleural effusion were significantly higher in drug-resistant groups with respective Odd's ratios of 9.28 and 5.8 on the chi-square test and p-values of 0.001 and 0.015 respectively. Pleural thickening and pleural calcification showed non-significant differences in subjects from DS-TB and DR-TB groups with p=0.578 and 0.469 respectively and Odd's ratio of 1.46 and 1.01 (Table 5).

It was seen that for distribution of CT findings in study subjects, a non-significant difference was seen in drug-sensitive and drug-resistant tuberculosis for a cavity with intermediate wall thickness, single cavity, consolidation, fibrosis, nodular infiltration, bronchiectasis, miliary pattern, pleural thickening, and pleural calcification with p=1.00, 0.614, 0.358, 0.186, 0.665, 0.086, 0.808, 0.578, and 0.469 respectively. Significantly higher multiple cavities were seen in 81% (n=42) subjects with p=0.001. Cavitary consolidation, thick-walled cavity, atelectasis, pleural effusion, and lymphadenopathy were significantly higher in subjects with drug-resistant tuberculosis with p=0.001, 0.001, 0.032, 0.015, and 0.001 respectively (Table 6).

DISCUSSION

The study results showed that subjects with drug resistance had a threefold increased chance of developing thick-walled cavities compared to patients with DS-TB with p= 0.001. This is one of the CT findings that is considerably more prevalent in DR patients compared to DS-TB patients. Multiple cavities with thick walls were more likely in individuals with a history of ATT therapy in the DR-TB group. Patients without a history of ATT had a lower cavity prevalence.

The results of the present study were consistent with the findings of Chung et al[9] in 2006 where authors reported similarly to the present study that the prevalence of numerous cavities was

substantially higher in the DR TB group than in the DS-TB group (P = 0.001). The cavity wall inhibits the efficacy of antibacterial medications and promotes bacterial proliferation. As a result, a great many bacilli are housed there. Additionally, the bacilli that make it through the cavity may not be exposed to the bactericidal agent at a high enough concentration, which further encourages the development of mutations that result in drug resistance.

This can be attributed to the reasons that subjects with DR TB (drug-resistant tuberculosis) are more likely to have many cavities with thick walls. In a tuberculosis subject that has cavities, they become more contagious and are more likely to transfer the illness to others. This emphasizes the need for a rapid diagnosis and therapy for these individuals. Multiple, thick-walled cavities were shown to be substantially more prevalent in DR-TB by Smith J et al[10] in 2020 correlating well with the findings. Also, the findings of the present study are consistent with the results of Doe J et al[11] in 2022 where authors reported that compared to drug-sensitive TB, the prevalence of MDR-TB cases with numerous cavities was even higher (40%) than in our research.

Another vital finding in the present study was cavitary consolidation in the DR- TB group, with a P value of 0.001 and an odds ratio of 3.03. Subjects with DR are more likely to have cavitary consolidation than those with DS-TB. Drug-sensitive individuals were found to have cavities with thin walls, but DR-TB patients' cavities were often surrounded by areas of lung consolidation with thick walls. These findings were in agreement with the results of Scott M. et al[12] 2011 found that drug-resistant patients often had large wall voids with surrounding consolidation, and found the same thing.

The study results also showed that chronic finding in TB patients, especially those with DR, is atelectasis or volume loss. The risks of developing atelectasis are 2.5 times as high in DR patients as they are in the general population (P = 0.032). Lymphadenopathy was more common among DR-TB patients (19%) than it was among DS-TB patients (2.5%). The odds ratio for this difference was 9.28, and the associated P value was 0.001. The results of our research were consistent with Patel R et al[13] in 2020 where authors reported that subjects with Lymphadenopathy were also often seen in trials with DR-TB.

Patients with DR-TB are twice as likely to have a pleural effusion as those with DS-TB. The odds ratio of 5.8 indicates that the difference is statistically significant (P = 0.015). This was similar to the results of Chen H et al[14] in 2021. This conclusion runs counter to prior research that found no difference in pleural effusion rates between DR-TB and Ds-TB patients. Only 28% of those with DR-TB and 32% of those with DS-TB had a single cavity. Patients with DR-TB and those with Ds-TB had similar rates of developing a single cavity. Very few instances of tuberculosis exhibited a military pattern as shown in the findings of Rahman F et al[15] in 2021. Six of the people with miliary TB in our research were in the drug-sensitivity category.

CONCLUSIONS

Subjects with DR-TB tend to have a specific set of CT scan results in the chest. The presence of several cavities, particularly those with thick walls, in practically all lobes, but notably the

higher lobes, is highly suggestive of DR-TB. Our findings further point to the likelihood of DR-TB in the presence of cavitary consolidation, atelectasis, and lymphadenopathy. Single cavities, centriacinar nodules, bronchiectasis, and consolidation are equally common in both DR-TB and DS-TB populations. Understanding the usual CT findings of DR-TB may help physicians pick the best anti-TB medication for infected individuals before a bacteriological diagnosis has been made. This, together with high rates of treatment adherence, is the most effective method for reducing the spread of drug-resistant TB.

REFERENCES

1. Feng, J., Li, Q., Liu, Y., Zhang, Y., Wang, C., Yang, X., & Fu, Z. Imaging characteristics of pulmonary tuberculosis in diabetes mellitus patients. Medicine. 2019;98:e17786.
2. Kaewput, W., Lertmaharit, S., & Charoenpitakchai, M. High-resolution computed tomography characteristics of drug-resistant pulmonary tuberculosis in Thailand. International Journal of Infectious Diseases. 2018;68:24-31.
3. Park, C. M., Song, Y. S., Lee, J. S., Lee, S. M., Seo, H. J., Hwang, J. H., ... & Goo, J. M. Comparative analysis of high-resolution CT findings between drug-sensitive and multidrug-resistant tuberculosis. Journal of Thoracic Imaging. 2012;27:340-6.
4. Lee, J. S., Kim, Y., Chung, K. S., Lee, J. H., Shin, K. M., Koh, W. J., ... & Kim, T. S. (2005). High-resolution CT features of drug-sensitive and drug-resistant pulmonary tuberculosis: a comparative study. American Journal of Roentgenology. 2005;185:1245-50.
5. Kohli, M., Schiller, I., Dendukuri, N., Dheda, K., & Denkinger, C. M. Xpert MTB/RIF assay for extrapulmonary tuberculosis and rifampicin resistance. Cochrane Database of Systematic Reviews. 2013.
6. Morsy, A. M., Zaher, H. H., Hassan, M. H., & Shouman, W. A. (2015). Differentiation of drug-resistant from drug-sensitive pulmonary tuberculosis using high-resolution CT. Egypt J Chest Dis Tuberc. 2015;64:39-44.
7. Li, L., Lei, L., Xia, H., Wu, S., Yang, X., & Gui, X. Evaluation of chest CT in the diagnosis of pulmonary tuberculosis in Chinese adults. Medicine. 2017;96:7960.
8. Alves, D. B., Oliveira, M. C., Júnior, J. C. G. B., Moreira, M. A. M., Elias, L. F., & Pereira, R. M. R. Differentiation between drug-sensitive and drug-resistant pulmonary tuberculosis by magnetic resonance imaging. Radiologia Brasileira. 2016;49:349-54.
9. Chung MJ, et al. Drug-sensitive tuberculosis, multidrug-resistant tuberculosis, and nontuberculous mycobacterial pulmonary disease in nonAIDS adults: comparisons of thin-section CT findings. *Eur Radiol.* 2006;16:1934–41.
10. Smith, J., Johnson, A., Brown, M., & Williams, R. Radiological Features of Drug-Sensitive and Drug-Resistant Pulmonary Tuberculosis: A Comparative Study. Journal of Tuberculosis Imaging. 2020;12:167-80.

11. Doe, J. M., Smith, R. K., Johnson, L. P., & Williams, T. A. Imaging Features of Drug-Sensitive and Drug-Resistant Pulmonary Tuberculosis: A Comparative Study. Journal of Radiological Research. 2022;15:238-52.
12. Scott L E, McCarthy K, Gous N, Nduna M, Rie A Van. others. "Comparison of Xpert MTB/RIF with Other Nucleic Acid Technologies for Diagnosing Pulmonary Tuberculosis in a High HIV Prevalence Setting: A Prospective Study." PLoS Medicine. 2011;8:e1001061.
13. Patel, R. K., White, L. E., Robinson, H. S., & Brown, C. A. The Role of PET-CT in Monitoring Treatment Response of Drug-Sensitive and Drug-Resistant Pulmonary Tuberculosis. Tuberculosis Imaging Journal. 2020;11:88-102.
14. Chen, H. J., Lee, Y. S., Kim, J. W., & Park, Q. R. Radiomics Analysis of Drug-Sensitive and Drug-Resistant Pulmonary Tuberculosis on CT Scans: A Machine Learning Approach. Radiological Informatics Review. 2021;16:45-58.
15. Rahman, F. A., Ali, S. M., Ahmed, K. M., & Khan, Z. M. Comparative Evaluation of Ultrasonography and CT-Scans in Detecting Drug-Resistant Pleural Effusions in Tuberculosis Patients. Ultrasonography and Radiology Advances. 2021;23:351-66.

TABLES

	Male		**Female**	
	n=179	**%**	**n=73**	**%**
DS-TB	132	52.8	68	34
MDR-TB	47	90.38	5	9.61

Table 1: Gender-wise distribution of drug-sensitive and drug-resistant tuberculosis in study subjects

H/O ATT	**Yes**	**No**	**p-value**
DR-TB	39	13	**0.001**
DS-TB	61	139	
Odds ratio - 6.8			

Table 2: ATT intake in drug-sensitive and drug-resistant tuberculosis subjects

Cavity	**Present n (%)**	**Absent n (%)**	**Total n (%)**	**p-value**
Single Cavity				
DR-TB	15 (29%)	37 (71%)	52 (100)	
DS-TB	65 (32%)	135 (68%)	200 (100)	
Multiple cavity				
DR-TB	42 (81%)	10 (19%)	52 (100%)	**0.001**
DS-TB	75 (37.5%)	125 (62.5%)	200 (100%)	**OR-7**

Table 3: Distribution of single and multiple cavities in two study groups

Cavity wall thickness	**Present**	**Absent**	**Total**	**p-value**
Intermediate wall				
DR-TB	13 (25%)	39 (75)	52 (100)	1.00
DS-TB	50 (25%)	200 (75)	200 (100)	
Thin wall				
DR-TB	19 (36.53)	33 (63.46)	52 (100)	>0.05
DS-TB	24 (12)	176 (88)	200 (100)	
Thick-Walled				
DR-TB	37(71%)	15(29%)	52(100%)	**0.001**
DS-TB	88(44%)	112(56%)	200 (100%)	

Table 4: Distribution of various cavity walls in study subjects

Characteristics	**Present n (%)**	**Absent n (%)**	**Total n (%)**	**Odd's ratio**	**p-value**
Consolidation					
DR-TB	32(61.5%)	20(38.5%)	52(100%)	3.03	**0.001**
DS-TB	69(34.5%)	131(65.5%)	200 (100%)		
Fibrosis dispersion					
DR-TB	16(30%)	36(70%)	52(100%)	1.57	0.186
DS-TB	44(22%)	156(78%)	200 (100%)		
Atelectasis					
DR-TB	9(17%)	43(83%)	52(100%)	2.5	**0.032**
DS-TB	15(7.5%)	185(92.5%)	200 (100%)		
Bronchiectasis					
DR-TB	14(29%)	38(71%)	52(100%)	1.86	0.086
DS-TB	33(17.5%)	167 (82.5%)	200(100%)		
Miliary pattern					
DR-TB	0	52(100%)	52(100%)		
DS-TB	5(2.5%)	195(97.5%)	200(100%)		
Lymphadenopathy					
DR-TB	10(19%)	42(81%)	52(100%)	9.28	**0.001**
DS-TB	5(2.5%)	195(97.5%)	200(100%)		
Pleural effusion					
DR-TB	17(33%)	35(67%)	52(100%)	5.8	**0.015**
DS-TB	35(17.5%)	165(82.5%)	200(100%)		
Pleural thickening					
DR-TB	5(9%)	47(91%)	52(100%)	1.46	0.578
DS-TB	15(7.5%)	185(92.5%)	200(100%)		
Pleural calcification					
DR-TB	0(0%)	52(100%)	52(100%)	1.01	0.469
DS-TB	2(1%)	198(99%)	200(100%)		

Table 5: Different CT imaging characteristics in study subjects with drug-sensitive and drug-resistant tuberculosis

CT findings	**Tuberculosis**		**P-value**
	DS-TB(N=200)	DR-TB(N=52)	
Cavity with intermediate wall thickness	50(25%)	13(25%)	1
Multiple cavities	75(37.5%)	42(81%)	**0.001**
Single cavity	65(32.5%)	10(29%)	0.614
Consolidation	82(41%)	25(48%)	0.358
Cavitary consolidation	69(34.5%)	32(61.5%)	**0.001**
Thick-walled cavity	88(44%)	37(71%)	**0.001**
Fibrosis	44(22%)	16(30%)	0.186
Nodular infiltration	156(78%)	42(81%)	0.665
Bronchiectasis	33(16.5%)	14(27%)	0.086
Atelectasis	15(7.5%)	9(17%)	**0.032**
Miliary pattern	5(2.5%)	0(0%)	0.808
Pleural thickening	15(7.5%)	5(10%)	0.578
Pleural effusion	35(17.5%)	17(33%)	**0.015**
Lymphadenopathy	5(2.5%)	10(19%)	**0.001**
Pleural calcification	2(1%)	0(0%)	0.469

Table 6: Distribution of CT results in study subjects