Section: Pulmonary Medicine

Original Research Article

CLINICO- RADIOLOGICAL CORRELATION OF PULMONARY CAVITIES- AN APPROACH FOR ACCURATE DIAGNOSIS

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Abstract

Background: Tuberculosis is the most common cause of pulmonary cavities. However not all the lung cavities are due to tuberculosis. The spectrum of diseases ranges from acute - chronic infections, systemic disorders and malignancies. There have been several instances where a malignant cavity was misdiagnosed as Tuberculosis and vice versa. Radiographic characteristics of a cavity can be useful to differentiate variable etiologies, and if combined with clinical and laboratory data, gives maximum results. **Materials and Methods:** A total of 153 patients with pulmonary cavities radiographically, were evaluated with necessary investigations like sputum for AFB, GeneXpert, DST, LPA, sputum cultures, KOH mount, fungal cultures, connective tissue profile, and sputum for malignant cells. Definitive diagnosis was obtained and cavity characteristics were described including size, number, location, wall thickness, margins, content, surrounding lesions and correlated clinically. **Result:** After thorough evaluation of 153 patients, though Tuberculosis was found to be the most common etiology (41.9%), lung cancers and certain other conditions like Granulomatosis with Polyangiitis, Pulmonary thromboembolism were also encountered. Most common location of cavities was Right upper lobe (57.5%). The inner/ outer cavity wall margins, thickness (P<0.001), age (mean –63.80±10.76), smoking history (P<0.005), clubbing and lymphadenopathy (P<0.001) were strongest predictors to differentiate benign vs malignant cavities. Wall thickness of cavity <5mm was more common in benign, thickness>15mm was purely seen in malignancy, cavities with 5-15mm thickness were mixed. Cavity wall characteristics like presence of solitary cavities, increased wall thickness and irregular inner and outer wall margins were strongest predictors for malignant cavities.Cavity location, content and surrounding lesions aid in identifying various pathologies. **Conclusion:** Tuberculosis is prevalent in India so likelihood of it being common cause of cavities is obvious. But accurate diagnosis is required as delay impacts prognosis especially in cancers. It is important to be well versed with features of cavities in different conditions, so that the diagnosis can be early and accurate.

INTRODUCTION

Chest radiograph is widely available, fast, and relatively cheap modality of diagnosis. Any suspicious abnormality on a chest x-ray triggers a further workup for establishing etiology. The radiological presence of cavities provides a clue for diagnosis of various diseases. Tuberculosis is by far the most common cause of pulmonary cavities. In case of Tuberculosis, the prevalence of cavities on plain radiographs varies widely by series, but most series report cavitation in 30 to 50% of patients. Multiple cavities are often present and frequently occur in areas of consolidation,[1,2,3] However not all lung cavities are due to Tuberculosis. It is extremely important to differentiate various cause of pulmonary cavities by taking clues from clinical and laboratory data. The spectrum of diseases ranges

from acute to chronic infections, chronic systemic diseases, and malignancies.[4]

There have been several instances where a malignant pulmonary cavity was misdiagnosed as Tuberculosis and vice versa. Lung Cancer and Pulmonary Tuberculosis (PTB) are known to coexist specially in regions with higher prevalence of PTB.

Another case of misdiagnosis of pulmonary cavity was reported by Simon Mifsud et al (2017), wherein the lung cavity in a 20 year old woman was initially thought to be bacterial in origin, however after a vigorous workup; a rare diagnosis of Pulmonary Echinococcosis was made.[6]

This study aimed to determine the etiology of pulmonary cavities based on its radiological appearance. Further, we aim to correlate the radiological features with clinical characteristics and the laboratory investigations.

MATERIALS AND METHODS

Ethical approval

The study was approved by Institutional Ethical Committee of Osmania Medical College, Telangana.

Patients and Methods

It is an observational study conducted on 153 patients having Pulmonary cavities on chest radiograph visiting (outpatient and inpatient) Government General and Chest Hospital, Hyderabad. Patients not willing for further workup were excluded. All the patients with a chest x-ray showing cavity were further evaluated. CT chest was done in those cases where chest x-ray was inconclusive. A complete history of presenting complaints, comorbidities, relevant past medical history, smoking history, and physical examination has been recorded in all cases. Patients were subjected to routine blood investigations. Sputum for acid fast bacilli and CBNAAT/genexpert was done for all cases to diagnose PTB. In case of suspicion for Multidrug resistant TB, Drug sensitivity testing (DST), first and second Line Probe Assay (LPA) was sent. Sputum culture was also done to rule out other bacterial and fungal infections. All other necessary investigations were done whenever there was a suspicion of other disorders i.e. connective tissue profile for disorders like Rheumatoid arthritis, Ankylosing spondylitis, sputum for malignant cells for lung cancers, KOH mount for fungal infections, etc. Flexible bronchoscopy was done in cases whenever there was a diagnostic uncertainty. Bronchial washings were taken in such cases and bronchial brushing/biopsy were taken when needed. After the entire diagnostic workup, a definitive diagnosis was obtained. The cavity characteristics in each case were compared and correlated clinically.

Data analysis

All data was collected, analysed and statistical analysis was done using SPSS V22 software. Descriptive statistics were represented with percentages, mean with SD. ANOVA & Chi-square test were applied to find significance. $P<0.05$ was considered as statistically significant.

RESULTS

Among 153 patients majority were in the age group of 31-50 and mean age was 44.84 years. 101 patients (66%) were males and 52 patients (34 %) were females. Majority of patients (84.3%) had normal body mass index (BMI) and the most common symptom was productive cough (119 cases, 77.8%). In the present study, 74 patients (48.4%) were smokers and 56 patients (36.6%) had previous history of tuberculosis. 49 %(n=75) of patients in this study had comorbidities of which 28.1 % (n =43) had hypertension and 20.3% (n =31) of them were diabetic. Two of the patients were post COVID 19, later diagnosed to have tuberculosis. Sputum of 53 (34.6%) patients' tested positive for AFB. Among 113 patients who underwent CBNAAT test, MTB was detected in 38 patients. Detailed description of Demographic and clinical profile of study population is mentioned in [Table 1].

The most common diagnosis was Tuberculosis either active or sequel of previous tuberculosis. Other etiologies of cavities were lung abscess, malignant cavities, and pulmonary thromboembolism. Etiology couldn't be established in four patients. Various diagnosis obtained are enlisted in [Table 2].

In the present study, out of 153 patients, 61.4 % (n=94) patients had single cavity and 59% had multiple cavities. The various etiologies correlating with number of cavities is depicted in [Figure1].

Right upper lobe-(37.3%) was the most common site followed by left upperlobe. Inner margin of cavity was smooth in 51% cases and irregular in 49%cases. Outer margin was smooth in 86.3% cases and irregular in 13.7% cases shown in [Table3].

Cavity wall thickness was assessed and 76.5% cavities were <5mm, 20.9% of cavities were in the range of 5-15mm, and 2.6% of cavities were > 15mm as shown in [Table 4]. Wall thickness of <5mm was found in active pulmonary tuberculosis, previous pulmonary tubercular cavities, relapse of pulmonary tuberculosis, aspergilloma, lung abscess ,Pulmonary Thromboembolism, GPA and primary lung cancer. Wall thickness of >15mm was found in Primary lung Carcinoma (75%) and combined pulmonary tuberculosis with primary lung cancer (25%) cases only as depicted in [Figure 2].

Associated Radiologic lesions were assessed and Consolidation was most common finding. Other lesions found were Fibrosis, Nodules, Bronchiectasis, Pleural involvement, Mediastinal lymph nodes and their frequency of occurrence is depicted in [Table 5].

Bronchoscopy was performed in 23.5 % of cases (n=36) to evaluate the cause of cavities. The need

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for invasive procedure like Bronchoscopy can be minimized if radiological diagnosis is adequately established and cavity characteristics are well understood priorly.

Bronchial biopsy/bronchial brushings revealed the diagnosis of squamous cell carcinoma of lung in 13 cases, metastatic deposits of prostatic adenocarcinoma and squamous cell carcinoma of oesophagus in 2 cases respectively. Bronchial washings for fungal culture isolated aspergillus species in 10 patients and CBNAAT detected Mycobacterium tuberculosis in 7 cases.

Bronchoscopy was normal in the case of Granulomatosis with Polyangitis (GPA). CT guided biopsy of the lung nodules revealed necrotizing granulomatous inflammation.

Bronchoscopy had no abnormality detected in 3 cases of undiagnosed pulmonary cavities.

[Table 6] shows characteristics and differences between benign and malignant cavities and p-values obtained in the study. ROC curve of the wall thickness showing optimal compromise between sensitivity and specificity, i.e. most accurate in differentiating benign from malignant cavities as shown in [Figure 3 and Table 7].

Table 1: Demographic and Clinical Data of Patients

Characteristics of study population	Number/Percentage
Age	
<= 20	12(7.8%)
21-30	26(17%)
31-40	31(20.3%)
41-50	31(20.3%)
51-60	24(15.7%)
>=60	29(19%)
Gender	
Females	52(34%)
Males	101(66%)
BMI	
<18.5	20 (13.1%)
18.5-24.9	129(84.3%)
>=25	4(2.6%)
Symptoms	
Cough	120 (78.4%)
Expectoration	119(77.8%)
Fever	107(69.9%)
Chest pain	4(2.6%)
Haemoptysis	45(29.4%)
Dyspnoea	36(23.5%)
Smoking Status	
Non smokers	79 (51.6%)
Smokers	74 (48.4%)
Past History Of TB	
Present	56 (36.6%)
Absent	97 (63.4%)
Sputum For AFB	
Positive	53 (34.6%)
Negative	100 (65.4%)
CBNAAT results	
MTB detected	38(33.6%)
MTB not detected	75(66.4%)

Table 2: Various Diagnoses Obtained Among Patients

Diagnosis	Frequency (Percentage)
Active Pulmonary Tuberculosis	64 (41.9%)
Old Pulmonary Tuberculosis	33 (21.6 %)
Pulmonary Tuberculosis relapse	17 (11.1 %)
Aspergilloma	10 (6.5 %)
Lung abscess	7 (4.6 %)
Primary lung carcinoma	13 (8.5%)
Lung metastasis	2 (1.3%)
PTB with Primary lung carcinoma	1 (0.7%)
GPA	1 (0.7%)
Pulmonary thromboembolism	1 (0.7%)
Undiagnosed	4 (2.6%)
Total	153 (100.0 %)

Table 3: Inner and Outer Wall Margins

Wall thickness	Frequency	Percent
< 5 mm	117	76.5
5 – 15 mm	32	20.9
> 15 mm	4	2.6

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Table 4: Wall Thickness of Cavities

Wall of cavities	Irregular	Smooth
Inner	75(49%	78(51%)
Outer	21(13.7%)	132(86.3%)

Table 5: Various Diagnoses Obtained Among Patients

Associated Radiologic lesions	Frequency	Percent
Fibrosis	65	42.5
Consolidation	99	64.7
Nodules	62	40.5
Bronchiectasis	29	19.0
Pleural involvement	42	27.5
Mediastinal lymph nodes	36	23.5

Table 6: Characteristics Differences between Benign and Malignant Cavities and P-Values

CHARACTERISTICS	BENIGN	MALIGNANT	P VALUE
AGE	42.78 ± 15.35	63.80 ± 10.76	<0.001 *
BMI	20.7 ± 1. 94	19.16 ± 1.39	0.028 *
GENDER- MALES	64.5 %	80 %	0.18
SMOKERS	46.4 %	86.7 %	0.003 *
CLUBBING	5.8 %	46.7 %	<0.001 *
LYMPHADENOPATHY	7.2 %	40.0 %	<0.001 *
CAVITY CHARACTERISTICS			
A. NUMBER- SOLITARY	58.0 %	93.3 %	0.005 *
B. INNER WALL MARGIN – IRREGULAR	43.5 %	100 %	<0.001 *
C. OUTER WALL MARGIN- IRREGULAR	6.5 %	80%	<0.001*
D. WALL THICKNESS			
< 5 mm	83.6 %	6.6 %	<0.001*
5- 15 mm	15.6 %	73.3 %	
>15mm	0 %	20 %	

Table 7: ROC Curve for Wall Thickness

Cut off value	6.55
Sensitivity	93.3
Specificity	98.6
PPV	87.5
NPV	99.27
Area under curve	0.973

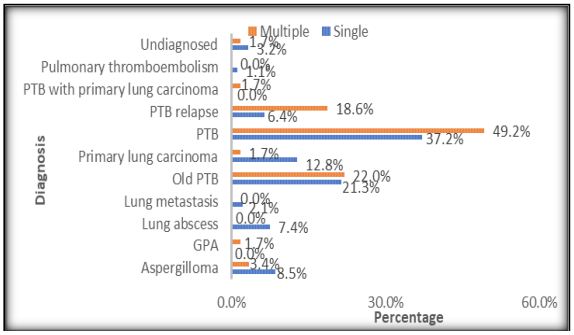

Figure 1: Diagnosis and Percentage of Single/Multiple Cavities

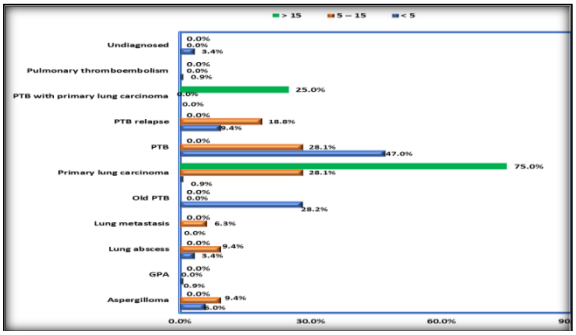

Figure 2: Wall Thickness of Cavities and Their Diagnosis

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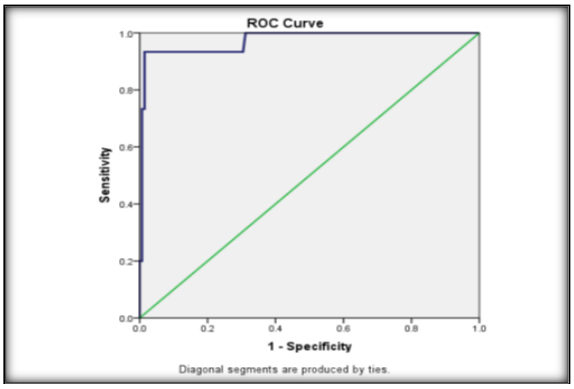

Figure 3: ROC Curve for Cavity Wall Thickness

DISCUSSION

Cavities are a common radiologic finding in a variety of different pathologic conditions. The cavity characteristics vary significantly in these conditions and these unique characteristics of cavity helps in early and easier diagnosis.

In resource limited setups, there is unavailability of extensive investigations, a plain radiograph can help in the diagnosis of cavity and additional expenditure can be avoided.

This study was undertaken with 153 patients showing cavities radiographically at Government General and Chest hospital, Hyderabad and results were analysed.

According to Indian TB report 2020, TB incidence is commoner in age groups 15-30 years. Malignancy however is more common in the older age group - more than 50 years. In the present study, majority of patients presenting with radiographic pulmonary cavities belonged to the age group of 31-40 years (31 patients, 20.3 %) as well as 41-50 years (31 patients, 20.3 %) and the most common diagnosis was tuberculosis.

In this study, the number of males presenting with lung cavities were greater (101 patients, 66%) in comparison with the female gender (52 females, 34%). This could be attributed to the fact that majority of pulmonary cavities are due to tuberculosis and according to WHO global TB report, men are significantly more at risk of contracting tuberculosis and dying from TB than women. Also, lung cancer, specifically squamous cell carcinoma which most commonly presents with cavities is more common in men than women.

Multiple pulmonary cavities were more common in active and old pulmonary tuberculosis. GPA also presented with multiple cavitating nodular lesions. Solitary cavity was observed more commonly than multiple cavities in aspergilloma, lung abscess, and primary and metastatic lung cancers. Tubercular lesions can affect single or even multiple lobes as the liquefied necrotic material can discharge into the airways and tend to involve multiple lobes. GPA usually presents with multiple cavitating nodules.

Location of cavity helps to provide a clue to the diagnosis. Post-Primary tuberculosis most commonly affects posterior segments of upper lobes and superior segment of lower lobes and post primary tuberculosis infections are more likely to cavitate compared to primary tuberculosis. Cavitation is most common in posterior segments of upper lobes. In case of lung abscess due to aspiration pneumonia with patient lying supine, superior segment of lower lobe and posterior segment of upper lobe is most commonly involved. Cavities due to active and old Pulmonary Tuberculosis, Aspergilloma, most commonly occurred in Right upper lobe followed by Left upper lobe. Lung abscess was most commonly observed in right lower lobe. Cavities due to Primary lung cancer were observed more commonly in left upper lobe.

In the present study, most cavities with a wall thickness at the thickest part <4mm were found to be benign and lesions with a wall thickness of >15mm were almost always malignant. Thus, thickness of cavity aids mainly in differentiating benign and malignant lesions.

Most of the active tubercular cavities and all the old tuberculosis cavities were smooth walled. The regularity of margins is an important distinguishing feature for etiological diagnosis of certain cavities. The wall of a pre-existing pulmonary cavity may lead to aspergilloma, which tends to be irregular. Irregularity of both inner and outer margins also suggests malignant etiology.

The content of cavity can provide clue in the diagnosis of aspergilloma, lung abscess, bronchogenic cysts and even sometimes in case of bronchogenic carcinoma. The degree of contrast enhancement of the content of cavity on a CT helps differentiate between benign and malignant etiologies. Lung abscess first begins with pneumonic infiltrate, followed by homogenous density with air fluid level, indicating the presence of bronchial communication. In aspergilloma, peripheral reabsorption of necrotic tissue causes retraction of infarcted centre and air filling in between it. Advanced age (mean age in malignancy- 63.80 ± 10.76), history of smoking, presence of lymphadenopathy and clubbing were significantly associated with malignant cavities ($p<0.001$).Cavity wall characteristics like presence of solitary cavities ($p<0.005$), increased wall thickness ($p<0.001$), and irregular inner and outer wall margins ($p<0.001$) were strongest predictors for malignant cavities.

Wall thickness of < 5mm was observed in 83.6 % of benign cavities, and 6.6 % of malignancies. Wall thickness of 5-15mm was found in 15.6% of benign cavities and 73.3% of malignant cavities. Wall thickness of >15mm was observed in 20 % of malignant cavities and 0% of benign cavities. This implied that, the greater the wall thickness of a cavity, the larger the likelihood of it to be malignant in etiology. Wall thickness of >15mm was highly specific for malignant cavities.

Malignant cavities are misdiagnosed as TB and vice versa. It's important to be well versed with features

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of cavities in different pathological conditions, so that the diagnosis can be accurate and treatment can be initiated early.

Limitations

The present study was based on observations of pulmonary cavity in patients aged >18 years of age and did not cover paediatric population and hence the diseases commoner in this age group were under-reported. Sample size needs to be more for such common radiologic finding. Retrospective/ Old Chest x-rays were not studied in case of healed cavities. CT-chest could not be performed in all the cases, it was done only in patients for whom diagnosis was inconclusive. Investigations for rare etiologies was not possible in four undiagnosed cavities.

CONCLUSION

The motto of undertaking this study is to provide diagnosis with minimal radiologic findings and limit exposure to radiation and other invasive investigations. In cost limitation setup, this study hints towards appropriate and early diagnosis thereafter saving time, energy and expenditure.

Therefore, analysis of cavities aids in various aspects which are interest of both treating physician and patient.

REFERENCES

1. Hadlock, F. P., S. K. Park, R. J. Awe, and M. Rivera. 1980. Unusual radiographic findings in adult pulmonary tuberculosis. Am. J. Roentgenol.134:1015–1018.
2. McAdams, H. P., J. Erasmus, and J. A. Winter. 1995. Radiologic manifestations of pulmonary tuberculosis. Radiol. Clin. N. Am. 33:655–678.
3. Woodring, J. H., H. M. Vandiviere, A. M. Fried, M. L. Dillon, T. D.Williams, and I. G. Melvin. 1986. Update: the radiographic features of pulmonary tuberculosis. Am. J. Roentgenol. 146:497–506
4. Parkar, A P and Kandiah, P 2016 Differential Diagnosis of Cavitary Lung Lesions. Journal of the Belgian Society of Radiology, 100(1): 100, pp. 1–8
5. Arulprashanth Arulanantham, Umesh Jayarajah, Rohitha Dharmasiri, Rasarathinam Jeyanthakumar, Kamila Niroshan Siriwardena, Sujeewa Ilangamge, "Squamous Cell Carcinoma in the Post Tuberculosis Lung after 30 Years of Treatment Completion", Case Reports in Surgery, vol. 2020, \
6. Mifsud S, Schembri EL, Gauci J, Mizzi A, Mallia Azzopardi C, Micallef J. The non-resolving lung cavity: a case of pulmonary cystic echinococcosis. BMJ Case Rep. 2017
7. Giacomelli IL, Barros M, Pacini GS, Altmayer S, Zanon M, Dias AB, Nin CS, Rodrigues RP, Marchiori E, Watte G, Hochhegger B. Multiple cavitary lung lesions on CT: imaging findings to differentiate between malignant and benign etiologies. J Bras Pneumol. 2019 Dec 20;46(2):e20190024
8. Yang YW, Kang YA, Lee SH, Lee SM, Yoo CG, Kim YW, Han SK, Shim YS, Yim JJ. Aetiologies and predictors of pulmonary cavities in South Korea. Int J Tuberc Lung Dis. 2007 Apr;11(4):457-62.
9. Nin CS, de Souza VV, Alves GR, do Amaral RH, Irion KL, Marchiori E, Hochhegger B. Solitary lung cavities: CT findings in malignant and non-malignant disease. Clin Radiol. 2016 Nov;71(11):1132-6
10. WHO World Health Organisation, Global tuberculosis report 2020
11. Alisjahbana B, Sahiratmadja E, Nelwan EJ, Purwa AM, Ahmad Y, Ottenhoff TH,Nelwan RH, Parwati I, van der Meer JW, Van Crevel R: The effect of type 2 diabetes mellitus on the presentation and treatment response of pulmonary tuberculosis. ClinInfect Dis 20.
12. Patel JC. Complications in 8793 cases of diabetes mellitus, 14 years study in Bombay Hospital, Bombay, India. Ind J Med Sci 1989;43:177.
13. Bacakoglu F, Basoglu O, Cok G, Sayiner A, Ates M. Pulmonary tuberculosis in patients with diabetes mellitus. Respiration 2001;68(6):595-600.

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