The Role of Some CT Criteria in the Diagnosis of Solitary Pulmonary Cavitary Lesion

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ABSCTRACT:

BACKGROUND:

The term cavity is a gas-filled space that appears on imaging as an area of low attenuation surrounded by a variously thickened wall within a pulmonary consolidation, mass, or nodule. Multidetector computed tomography (CT) of the chest is the current technique of choice for evaluating lung cavities.

OBJECTIVE:

To assess the role of some computed tomography criteria in differentiating benign from malignant solitary cavitary lung lesion.

PATIENT AND METHODS:

This was a cross sectional study done in the Computed Tomography unit of Al-Immamain Al-Kadhmain Medical city in Baghdad, Iraq between October, 2016 and June, 2017. All patients presented with solitary pulmonary cavitary lesions detected by chest x-ray referred for different reasons. Examination of the chest was performed by multi-detector CT (Somatom definition edge, SIEMENS medical system, Germany (256 slices)) with 2 sets of CT examination one before and another after giving IV nonionic iodinated contrast medium (Ultravist 370 mg /ml), 1.5 ml/kg Body weight. The final diagnosis was obtained depending on the sputum culture for AFB, bronchoscopy and biopsy, bronchoscopy and brush cytology and true cut biopsy.

RESULTS:

The study included 50 patients with solitary pulmonary cavitary lesions, 54% were male and 46% were females. Final diagnosis was 80% diagnosed as benign and 20% as malignant lesions. Enhancement was significant among 20% of studied patients. The common associated CT scan features were pleural effusion (24%), consolidation (12%), consolidation and tree in Bud (10%), pleural effusion and mediastinal lymph nodes (8%), tree in bud (10%), mediastinal lymph node and consolidation (8%), ground glass opacification, honeycombing and tree in bud (6%), pleural effusion and tree in bud (4%), fibrosis (2%) and encysted hydro-pneumothorax (2%). There was a highly significant association of significant enhancement and Pleural effusion with malignant solitary cavitary lesions ($p<0.001$ and $p=0.003$). A highly significant association was observed between increased mean thickness of lesion and malignant solitary cavitary lesion ($p<0.001$)

CONCLUSION:

The common computerized tomography characteristics of malignant solitary pulmonary cavitary lesions were significant enhancement, pleural effusion and increased diameter and thickness of pulmonary cavities.

KEYWORDS: solitary pulmonary cavity, CT scan.

INTRODUCTION:

The term cavity is a gas-filled space that appears on imaging examinations as an area of lucency or low attenuation surrounded by a variously thickened wall (greater than 4 mm) within a pulmonary consolidation, mass, or nodule and usually result from the drainage of necrotic lesions via the bronchial tree [(1)]. Pulmonary cavities are one of the most common features of the lung and are often encountered in chest imaging examinations, and their differential diagnosis includes diverse malignant and non-malignant diseases [(2)]. Various pathogenic mechanisms underlie the formation of cavitary lesions and include: inadequate local blood supply creating central necrosis, infarction from occlusion of regional nutritional vessels, and blockage of a bronchus resulting in necrosis distal to the obstruction [(3)]. Many malignant tumors and benign diseases can develop or

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present with cavities, and it is important to differentiate a cavitary malignant tumor from a benign lesion [4]. Up to 15% of primary lung cancers cavitate, mostly of squamous cell pathology [5]. Although the cavitation in pulmonary metastases is not as common as in primary pulmonary cancer, cavitating pulmonary metastases have been reported with primary lung, colon, stomach, head and neck, urinary bladder, kidney, uterine cervix, bone, pancreas, and breast cancers [3].

Multidetector computed tomography (CT) of the chest is the current technique of choice for evaluating lung cavities, as it provides precise information on size, shape, location of lesions, and other characteristics that may not be evident on CXRs [6, 7]. It is an important tool in the evaluation of mediastinal lymph nodes (LNs), and evaluating associated complications. It also can be used to differentiate the various etiologies and identifying pleural/ airway/ diaphragmatic pathologies and evaluating visualized bones. Contrast-enhanced CT (CECT) is the investigation of choice for evaluation of mediastinal LNs and also aids in depicting pleural enhancement in empyema [8].

AIM OF THE STUDY:

To assess the role of some computed tomography criteria in differentiating benign from malignant solitary cavitary lung lesion.

PATIENTS AND METHODS:

The Study was a cross sectional analytic study carried out in the Computed Tomography unit of Al-Immamain Al-Kadhmain Medical city in Baghdad, Iraq through the period from 1st October, 2016 to 30th June, 2017. All patients presented to Computed Tomography unit with solitary pulmonary cavitary lesions detected by chest x-ray referred from clinicians for different reasons. Research approval was taken from Institutional Review Board/ Al-Nahrain college of Medicine. Oral informed consent was taken from patients before enrolling in the study.

Inclusion criteria: adult patients with single cavitary lung lesion detected by chest x-ray regardless of symptoms. Exclusion criteria: multiple cavitay lung lesions, patients with known lung carcinoma on treatment, patients with known pulmonary tuberculosis on treatment and patients receiving chest radiotherapy.

Examination protocol: the examination of the chest was performed with multi-detector CT (Somatom definition edge, SIEMENS medical system, Germany (256 slices)). All the patients were examined in the supine position in caudo-cranial direction during breath holding period of 5-10 sec, Slice thickness 5mm, KVp 100-120, mA 200-300. All patients had 2 sets of CT examination one before and another after giving IV nonionic iodinated contrast medium (Ultravist370 mg /ml), the dose of contrast medium in an adult patient is given as 1.5 ml/kg Body weight and the magnitude of enhancement was assessed by measuring CT number pre- and post-contrast administration and was considered significant if the increase in CT number is more than 15 HU. Images were viewed in 2 different window settings: lung window (WL= -600, WW= -1600), and mediastinum window (WL=40, WW=350). Sagittal and coronal reformatted images were obtained from initial axial CT data.

Statistical analysis: all patients' data entered using computerized statistical software; Statistical Package for Social Sciences (SPSS) version 22 was used. Descriptive statistics presented as (mean ± standard deviation) and frequencies as percentages. Chi square test was used for comparison between categorical data (Fishers exact test was used when expected variables were less than 20% of total). Independent sample t-test was used to compare between two means. In all statistical analysis, level of significance (p value) set at ≤ 0.05.

RESULTS:

The study included 50 patients with x-ray diagnosis of solitary pulmonary cavitary lesions, 54% were male and 46% were females with male to female ratio as 1.1:1. The mean age of the studied group was 50.7±11.9 years; 4% of them were in age group <30 years, 10% of them were in age group 30-39 years, 34% of them were in age group 40-49 years, 22% of them were in age group 50-59 years and 30% of them were in age group ≥60 years. The clinical presentations of patients with solitary pulmonary cavitary lesions were: productive cough (94%), fever (70%), weight loss (56%), sweating (20%), anorexia (16%), and dyspnea (16%).

The final diagnosis of the 50 patients was: 80% of patients with solitary cavitary lesions were diagnosed by CT scan as benign and 20% of them were diagnosed as malignant lesions. Regarding specific diagnosis, the most frequent diagnosis was TB (60%), followed by; squamous cell carcinoma (14%), lung abscess (10%), hydatid cyst (10%), adenocarcinoma (4%), and metastasis (2%) as shown in table 1.

Table 1: The final diagnosis of patients with solitary pulmonary cavitary lesions.

Variable	No.	%
Diagnosis		
TB	30	60.0
Squamous cell carcinoma	7	14.0
Lung abscess	5	10.0
Hydatid cyst	5	10.0
Adenocarcinoma	2	4.0
Metastasis (adenoca.)	1	2.0
Total	50	100.0
Final diagnosis		
Benign	40	80.0
Malignant	10	20.0
Total	50	100.0

CT findings: The mean diameter of solitary cavitary lesions was 38.5±11.7 mm; with range of 15±58.5 mm. Mean thickness of solitary cavitary lesions was 8.6±8.1 mm; with range of 3±27.2 mm. The CT enhancement finding was significant among 20% of studied patients. The common associated CT scan features were pleural effusion (24%), consolidation (12%), consolidation and tree in Bud (10%), pleural effusion and mediastinal lymph nodes (8%), tree in bud (10%), mediastinal lymph node and consolidation (8%), ground glass opacification, honeycombing and tree in bud (6%), pleural effusion and tree in bud (4%), fibrosis (2%) and encysted hydro-pneumothorax (2%). There was a highly significant association between significant enhancement and pleural effusion with malignant solitary cavitary lesions ($p<0.001$ and 0.003 respectively) as shown in table 2.

Table 2: The patients' CT scan characteristics distribution according to CT scan findings.

Variable	Benign		Malignant		Total		
	No.	%	No.	%	No.	%	
Enhancement							
Significant	1	10	9	90	10	20	0.001** *Highly significant*
Non significant	38	95	2	5	40	80	
Associated features							
Pleural effusion	9	22.5	3	30.0	12	24.0	0.003** Significant
Consolidation	3	7.5	3	30.0	6	12.0	Non Significant
None	7	17.5	0	-	7	14.0	Non Significant
Consolidation & tree in bud	5	12.5	0	-	5	10.0	Non Significant
Pleural effusion and mediastinal lymph nodes	0	-	4	40.0	4	8.0	Non Significant
Tree in bud	5	12.5	0	-	5	10.0	Non Significant
Mediastinal lymph nodes and consolidation	4	10.0	0	-	4	8.0	Non Significant
Ground glass, honeycombing and tree in bud	3	7.5	0	-	3	6.0	Non Significant
Pleural effusion and tree in bud	2	5.0	0	-	2	4.0	Non Significant
Fibrosis	1	2.5	0	-	1	2.0	Non Significant
Encysted hydro-pneumothorax	1	2.5	0	-	1	2.0	Non Significant

*Chi-square test; **Fishers exact test.

The mean diameter of malignant cavitary lesions was significantly higher than mean diameter of benign cavitary lesions ($p<0.001$). A highly significant association was observed between increased mean thickness of lesion and malignant solitary cavitary lesion ($p<0.001$) as shown in table 3.

Table 3: The mean diameter and thickness of benign and malignant lesions in CT.

Variable	Benign (mm)	Malignant (mm)	P
	Mean±SD	Mean±SD	
Diameter (mm)	35.03±10.12	52.4±5.5	<0.001* Highly significant
Thickness (mm)	5.3±4.9	21.5±4.4	<0.001* Highly significant

*Independence sample t-test.

DISCUSSION:

It's important in clinical and radiological field to distinguish a cavitary malignant lesion from a benign lesion [9]. A continuous higher number of admissions to hospitals and health centers related with or mimicking tuberculosis has highlighted the issue of precise detection of tuberculosis and cancers. There are numerous interferences between both illnesses like they both are prevalent, have high incidence, include lung parenchyma or more all, described by closed presentations. Despite this, there are numerous dissimilarities between these two diseases like they have different etiology, diverse results, and treatment. Delay in the detection and treatment of lung malignancies lead to poorer result and lower survival [10].

The mean age of the studied patients with solitary pulmonary cavitary lesion was 50.7 years with high proportions of patients over 40 year's age. This finding is similar to that reported in a previous study in USA which stated that solitary pulmonary cavitary lesion were more prevalent among elderly patients and many radiology abnormalities especially among smokers were obvious after age of 50 years [6]. Other studies in India and USA reported that malignant cavitary lesion had higher incidence with increase of patient's age [11]. The incidence of lung cancer increases with age, with 60% of patients being over the age of 65 [12].

In this study the common significant CT characteristics of malignant solitary pulmonary cavities were significant enhancement, and pleural effusion. These findings are consistent with the results of many previous studies like Sim et al [13] study in UK, Li et al [9] study in China and Ödev et al [145] study in Turkey. Truong et al [15] documented that pleural effusion is more commonly found among patients with malignant solitary pulmonary nodules. CT scan contrast enhancement >15 HU is 99% predictive for benign lesions [16]. Malignant tumors are generally relatively more hypervascular in comparison to benign lesions and the intensity of enhancement is directly related to the vascularity led to the conclusion that the stronger the enhancement the more malignant potential of the nodule [17]. This enhancement cut off of 15HU resulted in an excellent sensitivity of 98% but unfortunately it was not very specific for malignancy, only about 50–60%. The general conclusion based on this report was that benign lesions usually enhance no more than 15 HU, whereas most of the malignant nodules develop more intensive enhancement, usually over 20 HU [18]. In a different study by Yi et al [19] with the enhancement cut-off of 30 HU, sensitivity for malignant nodules was 99% with a negative predictive value of 97%.

The appearance and thickness of a cavity wall can play useful role in diagnosis. Benign cavities tend to have smooth, thin walls, usually less than 4 mm at its broadest point, whereas nodules containing cavities with irregular, thick walls (exceeding 16 mm) have been found to be malignant in up to 95% of cases [17]. The present study showed that means diameter and thickness of malignant cavitary lesion were significantly higher than benign cavitary lesions. This finding coincides with results of Figueroa et al [20] study in USA and Nin et al [21] study in UK which reported that increase of diameter and thickness of solitary pulmonary cavities is significantly related to malignancy. Another study conducted in South Korea [22] revealed that wall thickness is significantly differentiating between malignant and benign cavitary lung lesions. Inconsistently, previous Chinese study [23] documented that cavitary wall thickness is unreliable for differentiating between malignant and benign lesions. Malignant pulmonary cavitation characterized by irregular or round appearance with discrepancy in wall thickness. The thickness above 24 mm in thickness with consolidation is predictive of malignancy [24]. The use of cavity wall thickness to discriminate among infectious etiologies of pulmonary cavities is even more problematic. While some infections, such as pneumocystis pneumonia, coccidioidomycosis, and Echinococcus, have been classically associated with thin walled cavities, the absence of comparative studies with systematic, objective measurements of cavity wall thickness among infectious etiologies severely limits the use of cavity wall thickness as a diagnostic tool in discriminating among infectious causes of cavities [25].

CONCLUSION:

The common computerized tomography characteristics of malignant solitary pulmonary cavitary lesions were significant enhancement, pleural effusion and increased diameter and thickness of pulmonary cavities.

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