CT CHARECTERIZATION OF CAVITORY LUNG LESIONS

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Summary

Background :

A cavity is a gas-containing space surrounded by complete wall which is 3mm or greater in thickness. Fleischner socity defines a cavity as a gas filled space within a zone of pulmonary consolidation , mass or nodule. Cavities are commonly encountered lesions in the lungs on chest radiography and chest computed tomography. The differential diagnosis of such lesions is broad because many different processes of congenital or acquired origin can cause these abnormalities .

The aim of this study :

To assess the role and value of CT in dignosing the nature and causes of pulmonary cavitary lesions.

Patients and methods :

Thirty-six patients ((16 (44.5 %) male and 20 (55.5 %) female, range in age from 1 – 80 years with mean age (35.6 % years))) were enrolled for this prospective cross sectional study. Three sets of CT images were obtained (lung , mediastinal & bone windows) to all patients. Sixteen patient underwent surgery, the resected specimens were sent for histopathology examination. Bronchoscopy was performed for 27 patient, bronchial wash sent for cytology, AFB, in addition to culture and sensitivity test.

Results :

Fourteen (39 %) patients with cavitary lung lesions proved to be ruptured H.C., 8 (22 %) cavitary TB ,7 (19.4 %) Bronchogenic carcinoma, 3 (8.4 %) pyogenic abscess, 2 (5.6 %) metastases and 2(5.6 %) were other lesions (sequestration and W.G.). In this study ruptured HC commonly seen in the Rt lower lobe (64%) ,. Air-fluid level is demonstrated in (35.6 %), daughter cyst sign (43 %), empty cavity sign (21.4 %). The cavites commonly solitary (85.7 %). , thin wall (71.4 %) & smooth contour (78.6 %). Most cavitory neoplasm encountered were bronchogenic carcinoma7 (85.7 %), most are sequamous type(n=6) , all cases seen with wall nodulation (N=7), most are thick wall (N=5). TB with cavitation that located in RUL (n=5), LLL (n=3). Thin wall cavities (n=6). Thick wall cavities (n=2), single cavity (n=5), multiple cavity (n=3), associated pleural effusion (n=3) and cavity with fluid level (n=2). Three patient present with cavitation due to pyogemic abscess. Right lung location (n=2), left lung (n=1), solitary (n=2), multiple (n=1), thin wall (n=2), thick wall (n=1), irregular wall (n=3), fluid level(s) (n=3) associated consolidation (n=1).

Conclusion :

Characterization of cavitary lesions by spiral CT of lung can narrow the list of differential diagnosis. CT of the chest is valuable procedure in characterizing cavitary diseases. Morphology, location, distribution and associated radiological finding provide important clues to the nature of the underlining diseases.

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CT charecterization of cavitary lung lesions

INTRODUCTION

A cavity is a gas-containing space surrounded by complete wall which is 3mm or greater in thickness. Cavitation occurs when an area of necrosis communicate with a patent airway [(1)]. Fleischner socity defines a cavity as a gas filled space within a zone of pulmonary consolidation , mass or nodule[(2,3)]. Cavities are commonly encountered lesions in the lungs on chest radiography and chest computed tomography. The differential diagnosis of such lesions is broad because many different processes of congenital or acquired origin can cause these abnormalities (table 1)

Neoplasm

Cavitation can be identified in tumours of any size and is best demonstrated by CT. It occurs in approximately (10 % -15 %) of bronchogenic carcinoma, more commonly with sequamous cell carcinoma than with other cell types [(4)]. Cavitation can occur in lung metastases from any primary site , but is more in squamous carcinoma, than others (adeno carcinoma, sarcoma, melanoma and rarely osteosarcoma) [(5)].

Pulmonary Tuberculosis (TB)

Tuberculous cavitation most commonly occurs within areas of consolidation and indicates a high likelihood of activity. Cavitation is seen in 40-80% of cases. May be single or multiple, large or small. The thickness of the wall varies from a hairline to a few millimeters and is usually smooth[(6,7)].-fluid levels are rare, but when present they suggest the possibility of superinfection[(8,9.10)].

Hydatid disease[(11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26)] :

Cavitation produced by rupture hydatid cyst that communicate with an airway producing several known CT Morphological appearance

Crescent , inverse crescent or signet ring :

Air between pericyst and endocyst producing radiolucent air shadow in a form of crescent which is a sign of impending rupture.

Double arch sign or combo sign:

Air-fluid level insides partially collapse endocyst that cupped by air crescent between pericyst and ectocyst.

Membrane sign :

Indulating collapse membrane floating on retained Hydatid cyst fluid. It is a counterpart of waterlilly sign on CXR.

Whirl sign :

Ring within ring.

Empty cavity sign :

When cyst fluid expelled completely resulting in trans lucent cavity.

Daughter cyst sign :

Intact daughter cyst(s) inside a partially or completely drained cyst , equal to serpent sign in CXR.

CT can demonstrate a number of these signs , some of them pathognomonic , to better advantage than the chest radiograph. Infected cyst may show small bubbles of gas and ring enhancement on CT [(27)].

Infection

Cavitation within a consolidated lung is seen in necrotizing pneumonia, most commonly caused by staphylococcus aureus, gram negative bacteria and anaerobes. A rapid cavitation of lobar consolidation is a feature of klebsiella pneumonia [(28)].

Inflammation

Non infections inflammatory processes associated with cavitary lung lesions include pulmonary vasculitis such as

Wegner`s granulomatosis and Rheumatoid nodules. Classic Wegner`s granulomatosis involve the upper respiratory track , the lung and the kidney's. The lung involves in 95 % of patient. Granulomatous masses up to several centimeters in diameters may appear on chest radiograph and it is fairly well defined and often cavitate [29]. Diagnosis can be made on histopathological examination of lung biopsy or by demonstration of serum antineutrophil cytoplasmic antibodies (ANCA).

Congenital Lesions

Several congenital lesions of the lung resemble a pulmonary mass. These lesions may become superinfected and present as an cavity or recurrent pneumonia. Pulmonary sequestration (PS) is a congenital mass of aberrant pulmonary tissue that has independent blood supply from the rest of the lung while cystic adenomatoid malformation (CAM) is adenomatous over growth of terminal bronchioles at the expense of alveolar development it is usually communicate with the tracheobronchial tree [30].

AIM OF THE STUDY

To assess the role and value of CT in dignosing the nature and causes of pulmonary cavitary lesions.

PATIENTS & METHODS

Thirty-six patients with cavitary lesions defined by computed tomography examination presented to Surgical specialities Hospital and Al-Kadhimia Teaching Hospital were enrolled for this prospective cross sectional study.

CT examination was as follow :

- All Patients were examined in supine position in caudo-cranial direction during breath holding period of 20-30 sec
  1-Slice thickness 5 mm.
  2-KVp 120-140.
  3-mA 100-200
  4-All patients had two sets of CT examination one before & another after giving IV nonionic iodinated contrast medium (Omnipaque 350 mg /ml),the total dose of the contrast medium in adult is 100 ml .
- Three sets of CT images were obtained (lung , mediastinal & bone windows).
- Sagittal &coronal reformatted images were obtained from initial axial CT data images.

Sixteen patient underwent surgery, the resected specimens were sent for histopathology examination. Bronchoscopy was performed for 27 patient, bronchial wash sent for cytology, AFB, in addition to culture and sensitivity test.

RESULTS

There were 16 (44.5 %) male and 20 (55.5 %) female, range in age from 1 – 80 years with mean age (35.6 % years).Fourteen (39 %) patients with cavitary lung lesions proved to be ruptured H.C., 8(22 %) cavitary TB,7(19.4 %) Bronchogenic carcinoma, 3 (8.4 %) pyogenic abscess, 2 (5.6 %) metastases and 2(2.8 %) were other lesions (sequestration and W.G.).(Table 2**)**

Rupture Hydatid cysts

In this study 14 (39 %) were ruptured HC. , The cavities were located in RLL (n=9), LUL (n=1), LLL (n=4). (Table 3)

Air-fluid level is demonstrated in six patients, daughter cyst sign (n=5), empty cavity sign (n=3). The cavites were multiple (n=2), solitary (n=12). Various wall shapes encountered were thin wall

(n=10) thick wall (n=4) irregular (n=3). (Table 4, 5)

Cavitary neoplasm

Nine patients had cavitary neoplasms , 7 were bronchogenic carcinoma. SCCA (n=6) adenocarcinema (n=1).The remaining two cavites were due to metastases to lung from Osteosarcoma and breast. (Table 6)

The spiral CT of cavitary bronchogenic carcinoma reveal that thin wall (n=2) , thick wall (n=4) , wall nodularity (n=6) , spiculation (n=1) , fluid level (n=2) , pleural effusion (n=2) , hilar lymphadenopathy (n=5). (Table 7)

Tuberculosis

Eight patients have TB with cavitation that located in RUL (n=5), LLL (n=3). Thin wall cavities (n=6). Thick wall cavities (n=2), single cavity (n=5), multiple cavity (n=3), associated pleural effusion (n=3) and cavity with fluid level (n=2). (Table8)

Pyogenic abscesses

Three patient present with cavitation due to pyogemic abscess. Right lung location (n=2), left lung (n=1), solitary (n=2), multiple (n=1), thin wall (n=2), thick wall (n=1), irregular wall (n=3), fluid level(s) (n=3) associated consolidation (n=1). (Table 9)

Others

Cavitation due to other lesions were Sequestration and Wegener`s granulomatosis. (Table 10)

DISCUSSION

The differential diagnosis for cavitary nodules or mass follows the mnemonic (CAVITY)[2].

C– Carcinoma – typical squamous.

A– Autoimmune– Wegner`sgranulomatosis and Rheumatoid arthritis

V– Vascular – emboli

I – Infection – lung abscess , Tuberculosis , Hydatid disease.

T – Trauma – lung laceration.

Y – Young – congenital lesions.

Ruptured Hydatid Cyst

Hydatid disease is a major health problem in the middle east. In Iraq it's considered to be one of most serious helminthic disease. This study revealed that rupture HC is the commonest cause of cavitary lung lesions,this because most of our cases are refered from thorasic surgery center. Regarding the location of complicated H.C. cavity; the RLL (64%) was commonest to be affected and least affected lobe was LUL (7%) , these results were comparable to Elhassani and Al-Sheikh[31]. Ruptured H.C. had different CT signs air-fluid level were in (35.6%), membrane sign (43%) empty cavity sign (21.4%). These figures is comparable to other study[32]. In our study there is (85.7%) solitary complicated cyst and (14.2%) multiple. This figure is higher than other study[32] because they take intact and ruptured cyst while only rupture HC. are taken in our work or may be due to smaller study sample. About (72%) of rupture HC. cavity were of thin wall and smooth, Saksouk etal (1988)[32] observed that most of complicated cyst were of thin wall also.

Neoplasm

Bronchogenic carcinoma in Iraq is being diagnosed with increasing frequency. CT appears to play an important role in the evaluation of patients with suspected lung cancer. Cavitating Carcinoma were 7 cases most of them were in right lung (71.5%) and this is in agreement with fact that the majority of pulmonary neoplasm develop in right lung as it comprise (55%) of lungs parenchyma [33]. The cell type of cavitary primary neoplasm were (85.7%) squemous cell type , (14.3%)

adenocarcinoma and this in agreement with fact that SCCA is much the likely cell type to show cavitation[34]. Typically malignant cavities are thick wall with irregular, nodular inner margin but some may appear thin wall [34] which is similar to our study.

Cavitating Secondaries

Cavitation occur in (4%) of lung metastases. It is more frequently occur in squamous cell type and more common in upper lobe [35]. In our study two cavities were due to metastases both are found in lower lobe and this differ from other study which found it more in upper lobe [35]. from other study which found it more in upper lobe [35], and this may be due to small study sample.

Pulmonary tuberculosis

Tuberculosis cavities most commonly occur within an area of consolidation and indicate a high likelihood of activity [7].In our study8(22%) patients have cavitary TB. most of them were in the right lung (62.5%) particularly posterior segment of upper lobe , majority were of thin wall (75%), thick wall cavities were (25%) which may be due to superadded infection.Fluid level is uncommon and demonstrated only in 2 patients, while associated pleural effusion were seen in (37.5%), these results found to be comparable with other study[7].

Pyogenic abscess

Lung abscess was a devastating disease in the pre-antibiotic era, when one third of patients die, another one third recover and the remainder developed debilitating illnesses. In our study 3 cavities were due to lung abscess, all are of irregular wall shape and have fluid level, majority of them were solitary and located in right lung which is comparable to other study [36]. A wall thickness of lung abscess progress from thick wall to thin and from ill define to well circumscribe as the surrounding lung infection resolve [37], this may explain the thin wall cavities (66.6%) in our study.

Miscellaneous causes

Two cavities were due to WG and sequestration. The nodules in WG may be solitary in one third of patients, cavitate in up to half cases but usually resolve over a period of months. It usually have thick wall cavity and of irregular outline and usually multiple. The results in our study were comparable to other study [38], except that it was a solitary cavity which may explained by solitary case in our study. Sequestration (IPS) is a congenital lesion when missed it may present later due to repeated infection that may progress to cavity formation. In our study one case was due to sequestration which prove to be intralober type of thick irregular wall, same result also found in other study [39].

CONCLUSION

- Characterization of cavitary lesions by spiral CT of lung can narrow the list of differential diagnosis.
- CT of the chest is valuable procedure in characterizing cavitary diseases. Morphology, location, distribution and associated radiological finding provide important clues to the nature of the underlining diseases.
- Although the Sequmous cell carcinoma is the most cavitating primary neoplasm of the lung, Adenocarcinoma can present as cavitary mass.
- Even by CT complicated Hydatid cyst. which present as cavitary lesions can be falsely diagnosed as other pulmonary lesion, but as the disease is endemic in our country, these findings may provide correct diagnosis taking in consideration the pathognomonic sign like membrane sign and whirl sign.

FIGURES

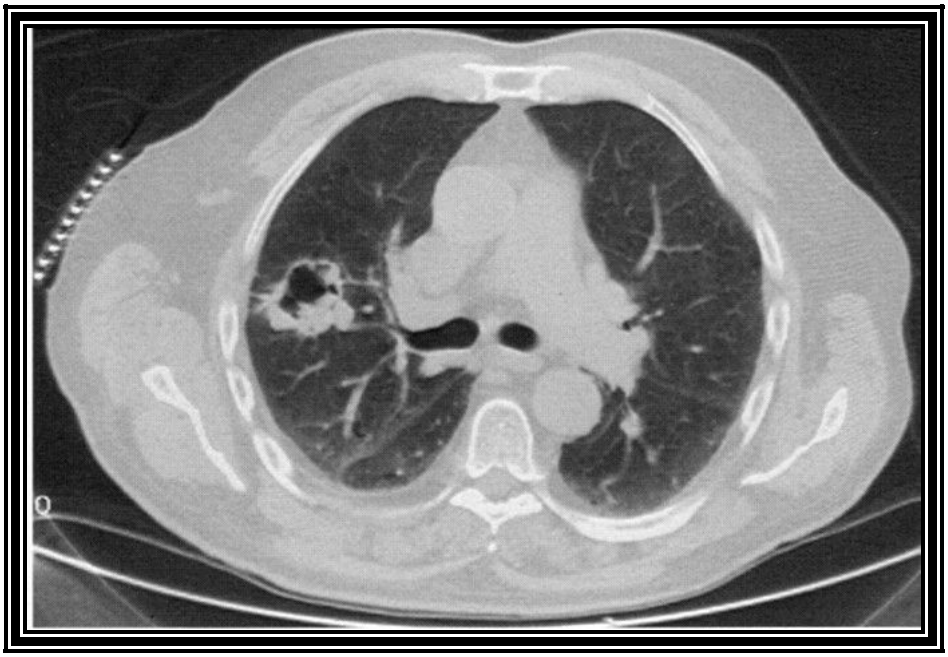

Fig 1.Squamous cell carcinoma

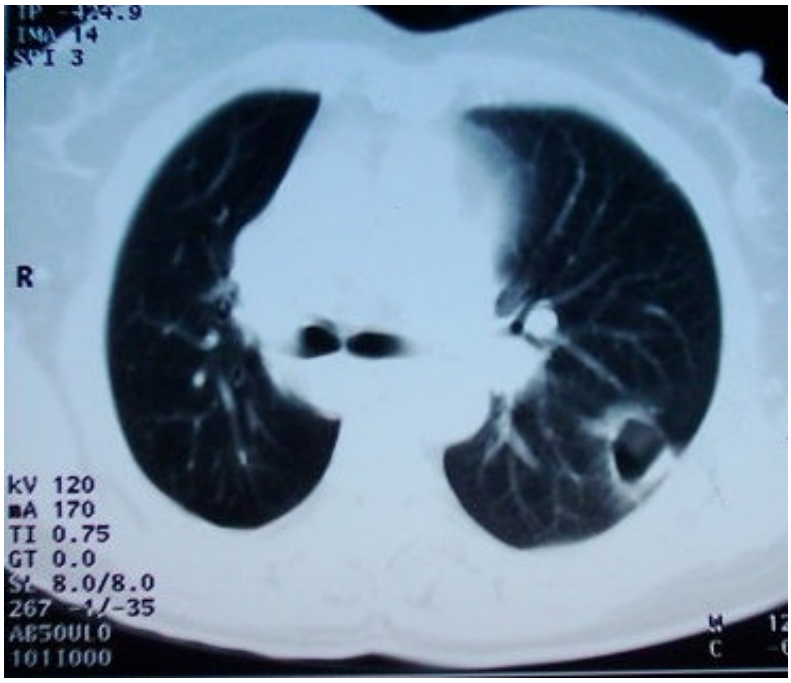

Fig 3. Rupture Hydatid Cyst

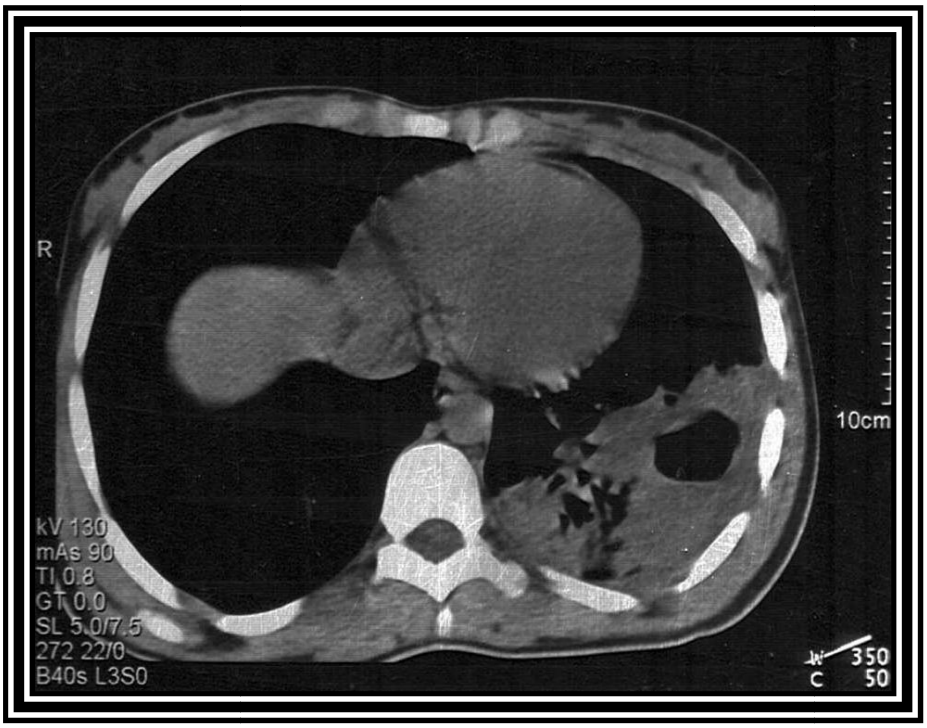

Fig 4. Abscess

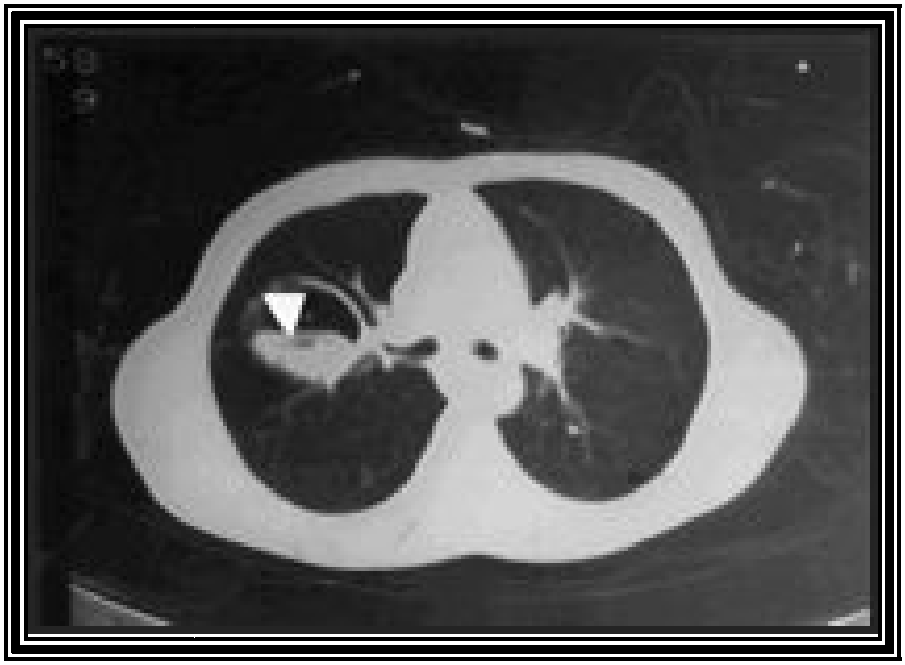

Fig 5. Ruptured hydatid (memberane sign)

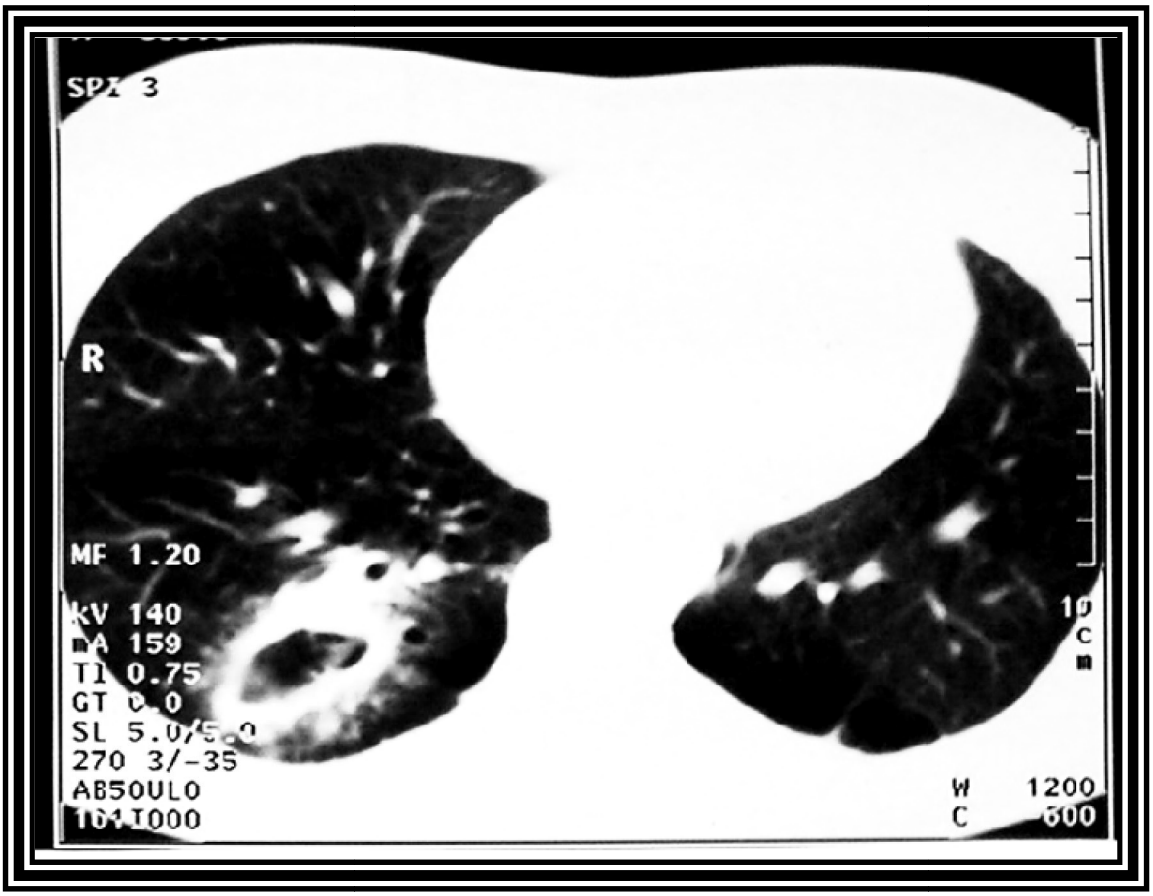

Fig 6. Rupture hydatid cyst

Fig 8. Tuberclosis

TABLES

Table (1) causes of cavitary lung lesion

Cavitary (wall thickness)≥3 mm or surrounding infiltrate or mass
Neoplastic
Bronchogenic carcinomas
Metastases
Lymphomas
Infections
Bacteria
Staphylococcus aureus , gram-negative bacteria , pneumococcus , mycobacteria , melioidosis , anaerobes , actinomycosis , nocardiosis
Fungi
Histoplasmosis , coccidioidomycosis , blastomycosis , Aspergillosis , mucormycosis , cryptococcosis , P carinii .
Parasites
Hydatid disease , paragonimiasis , amebiasis
Immunologic
Wegener granulomatosis
Rheumatoid nodule
Thromboembolism or septic embolism
Progressive massive fibrosis (pneumoconiosis)
Bronchiectasis , localized
Congenital lesions
Sequestration
Congenital adenomatoid malformation

Table 2 : Incidence of cavitation in different lung disease

Disease	No. cases	%
Hydatid disease	14	39
TB	8	22
Bronchogenic Carcinoma	7	19.4
Pyogenic abscess	3	8.4
Metastases	2	5.6
Wegener`s granulomatosis	1	2.8
Sequestration	1	2.8
Total.	36	100

Table 3: Lobar distribution of ruptured Hydatid cyst cavity according to CT finding

Pulmonary lobes	Ruptured HC n=14	%
RLL		
Anterior segment	1	7.0
Lateral segment	3	21.4
posterior	5	35.6
LUL		
Anterior segment	1	7.0
LLL		
Anterior segment	4	29
Posterior segment		
Total	14	100

Table 4: CT finding of rupture H.C.

Spiral CT finding	No.	%
Sign of rupture H.C.		
Air-fluid level	5	35.6
Daughter cyst sign	6	43
Empty cavity sign	3	21.4
Multiplicity		
solitary	12	85.7
Mutiple	2	14.2

Table 5: wall thickness , wall contour & wall enhancement of H.C.

Wall thickness		Wall contour		Wall enhancement
Thin	Thick	Smooth	Irregular	
10 (71.4%)	4 (28.6%)	11 (78.6%)	3 (21.4%)	6 (42.4%)

Table 6 :Number and percentage of cavitary neoplasm according to the histopathology and location.

Histopathology		Rt. lung			Lt. lung	
Primary neoplasm N=7	No.	RUL	RML	LLL	LUL	LLL
Squamous cell carcinoma	6	3	1		2	
Adenocarcinoma	1			1		
Secondary neoplasm N=2						
Osteosarcoma	1			1		
Breast	1			1		

Table 7: CT findings of cavitary neoplasm

Histopathology	No.	Wall thickness		Nodularity	spiculation	Fluid level	Associated finding	
		Thin	Thick				Pleural effusion	Hilar LAP.
Squamous cell carcinoma	6	2	4	6	1	2	3	
Adeno-carcinoma	1		1	1	-	-	1	1

Table 8 : CT finding of cavitary TB.

Pleural effusion	Fluid level	Lesion site			Wall thickness		Multiplicity	
		Rt. lung		Lt. lung	thin	thick	single	multiple
3	2	RUL		LLL	6	2	5	3
		Apical	posterior	Apical				
		1	4	3				

Table 9 : CT finding of pyogenic abscess

multiplicity		Wall thickness			Contour	Fluid level	Associated consolidation	location	
solitary	multiple	thin	thick	regular	irregular			Rt. lung	Lt. Lung
2	1	2	1		3	3	1	2	1

Table 10 : CT findings of other cavities

Disease	Location					Wall Contour		Wall Thickness	
	Rt. Lung			Lt. Lung					
	RUL	RML	RLL	LUL	LLL	regular	irregular	thin	thick
Sequestration					1		1		1
Wegner's granulomatosis			1			1			1

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توصيف المفراس الحلزوني لافات الرئة الكهفية

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الخلفية:الاحتمالات التشخيصية لأفات التكهف الرئوي هي واسعة ،يظهر التكهف بحوالي ٢-١٠ % من سرطان الرئة وخاصة نوع حرشفي الخلية وكذلك من الممكن ان يظهر في السرطان الغدي،ورم النسيج الضام،الاسود الخبيث ونادرا في سرطان العظم.العقد المتنخرة في حبيبوم وكنر والمرض الرئوي من الممكن ان تتكهف.الخمج بواسطة البكتريا الهوائية واللاهوئية ايضا بالامكان ان تتكهف وكذلك مرض التدرن الرئوي والاكياس المائية .

المرضى والطرق:ستة وثلاثون مريضا تم ادراجهم في البحث من خلال مستشفى الجراحات التخصصيةومستشفى الكاظمية التعليمي اجري المفراس الحلزوني لجميع المرضى وتم ملاحضة عدة نتائج (المكان ،سمك الجدار ،التناسق ،التعددية ،اشكال الرئة الغير طبيعية وكذالك وجود مستوى السوائل).

التشخيص النهائي تم التوصل اليه من خلال اخذ خزعة والتشخيص النسيجي وناضور الرئة واختبار سرعة حامضية العصيات بالاضافة الى الزرع البكتيري ومقارنة النتائج اعلاه مع نتائج المفراس الحلزوني.

النتائج:ستة وثلاثون مريضا كان متوسط اعمارهم (٣٥,٦) سنة ويتراوح بين ١-٨٠ سنة .اربعون منهم (٣٩%)لديهم كيس مائي متمزق وثمانية(٢٢%) لديهم تدرن رئوي وسبعة(١٩،٤%) لديهم سرطان رئوي واثنان(٥،٦ %) لديهم انبثاث سرطاني رئوي.معظم مرضى الاكياس المائية كان لديهم التكهف في الفص السفلي الايمن للرئة .اكثر علامات المفراس الحلزوني هي الاكياس المائية الممزقة والتي يضهر فيها مستوى التباين للهواء والسائل بحوالي خمسة مرضى (٣٥،٦%) وستة لديهم علامة الغشاء (٤٣%) وثلاثة لديهم كيس فارغ (٢١،٤%).
النتائج الاخرى التي وجدت هي ضعف جدار التكهفات وعددهم عشرة (٧١,٤%) واحدعشر تكهفات ذات محيط صقيل (٧٨،٦%) .الافات التكهفية الاخرى هي السرطانات الرئوية (١٩،٤%) ومنها السرطانات الحرشفية الرئوية (٨٥،٧%) والسرطانات الغدية (١٤،٣%) .اثنان من المرضى كان لديهم انبثاث سرطاني ثانوي تكهفي.
التكهف بسبب التدرن كان عددهم ثمانية (٢٢%) خمسة في الرئة اليمنى (٦٢،٥%) وثلاثة (٣٧،٥%) مصاحب بانصباب جنبي واثنان (٢٥%) فيه مستوى سائل .
التكهف بسبب الخراجات المتقيحة كان عددهم ثلاثة (٨،٤%) جميعها (١٠٠%) ذات جدار غير منتظم .اثنان (٦٦،٦%) كانت في الرئة اليمنى .

الاستنتاج:وصف الافات الرئوية التكهفية بواسطة المفراس الحلزوني قد قلص من الاحتمالات التشخيصية مع الاخذ بنظر الاعتبار الشكل،الموقع ،التوزيع ونتائج البيانات السريرية.

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