EVALUATION OF THE DIAGNOSTIC ACCURACY OF A COMPUTED TOMOGRAPHY-BASED SCORING SYSTEM IN THE DIFFERENTIATION BETWEEN MALIGNANT AND BENIGN PLEURAL EFFUSION

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ABSTRACT:

Background: *Pleural effusion in particular is considered a sign of an underlying pathology, so it is imperative to search for the underlying cause and find out whether it is a benign or malignant one as they are completely different in their treatment and prognosis.*

Aim of the work: *Our study aiming to appraise the validity and accuracy of contrast-enhanced CT chest as a non-invasive tool to predict the nature of pleural effusion whether benign or malignant using the CT-based scoring system established by Porcel et al.*

Patients and Methods: *This was a retrospective study that involved reviewing the contrast-enhanced CT chest done at the radiodiagnosis department in Ain Shams University Hospitals of 30 adult patients (age >18 years old) with unilateral or bilateral pleural effusion and scoring it according to the Porcel et al CT scoring system while being blinded to the final diagnosis. The total score was then compared to the biopsy or cytology of the patient to determine its accuracy.*

Results: *Analysing the data showed that the highly significant item of the scoring system denoting malignancy was pleural lesions followed by lung masses, liver metastasis, abdominal masses, and absence of pericardial effusion. The cutoff value in our study was found to be total score >7 denoting malignancy with a sensitivity of 94.12%, a specificity of 100%, a PPV of 100, a NPV of 92.2 and AUC = 0.986. On the other hand, the cutoff value of Porcel et al (≥7 denotes malignancy) gave a sensitivity of 94.1%, a specificity of 92.3%, a PPV of 94.12, a NPV of 92.31, and an accuracy of 93.33% in our study while in their study gave a sensitivity of 88%, a specificity of 94%, and AUC = 0.919.*

Conclusion: *This is a straightforward modality by means of chest computed tomography scan with a scoring system, which incorporates the following evaluations: pleural nodulations or pleural thickening, Hepatic metastases, Abdominal metastasis or masses, lung pathology as nodules or masses, pleural encysted loculations, cardiomegaly with or without pericardial fluid. CT Chest with contrast can be consistently applied to differentiate the etiology of pleural effusions with great accuracy yet it does not replace pleural fluid cytology/biopsy as a requirement for verification. Additional studies reviewing this CT scoring system are recommended.*

Keywords: *contrast-enhanced CT chest, CT-based scoring system, benign pleural fluid, malignant source effusion.*

INTRODUCTION:

Pleural effusion is the collection of fluid inside the pleural cavity, it arises as a consequence of discrepancy between pleural fluid production and reabsorption. It also occurs as a sign of an underlying pathology of the lung, pleura, or systemic disorders which can be either malignant or benign such

as heart failure, pneumonia, tuberculous pleuritis, or pulmonary embolism. Pleural effusion presents usually as dyspnea, dry cough, chest pain, and orthopnea [(1)].

Pleural effusion can be sorted as exudate, transudate, empyema, chylothorax, and hemothorax. The highly critical issue regarding of pleural effusion is that Its detection helps in early diagnosis and determination of the underlying cause either benign or malignant. Early diagnosis and treatment of benign pleural effusion progresses to complete resolution and avoids subsequent complications while early diagnosis and management of malignant pleural effusion corrects outcomes and improves the quality of life and enhances survival rates of the patients [(2&3)].

Unfortunately, the pleural effusion causes differential diagnosis is perplexing. The traditional methods used in the identification of the cause of pleural effusion, like *Ziehl-Neelsen* staining, fluid culture and sensitivity, and pleural biopsy are not decisive (about 20–40% of patients are left without a definite diagnosis requiring more invasive procedures like medical thoracoscopy or thoracotomy). Invasive procedures like thoracoscopy and thoracotomy require well-trained personnel and patients who are suited for such invasive procedures. patient who has pleural adhesions cannot undergo thoracoscopy [(4&5)].

The preferred method in the diagnostic process of pleural disorder is contrast-enhanced CT chest that can discriminate the different signs between the benign and the suspicious malignant pleural pathology. The most expressive signs of underlying pleural malignancy are pleural thickening and nodules [(5)].

A CT scan scoring system was established by Porcel et al, to help differentiate malignant from benign pleural effusion which included: The existence of a pleural pathology (ie, nodulations, masses, or focal/diffuse thickening) ≥ 1 cm (5 points); the incidence of hepatic focal metastases, or an abdominal suspicious lesions(mass), also existence of a lung pathology like mass or pulmonary nodule ≥ 1 cm (3 points each); and the absenteeism of any pleural encysted loculations, cardiomegaly with or without pericardial fluid (2 points each). A CT score of ≥7 is supposed to predict malignancy [(6)].

AIM OF THE WORK:

The aim of this study is to assess the validity and accuracy of contrast-enhanced CT chest as a non-invasive tool for detection of the nature of pleural effusion whether benign or malignant using the CT-based scoring system established by *Porcel et al.*

PATIENTS AND METHODS:

Our work was a retrospective study by including 30 adult patients (age >18 years old) with unilateral or bilateral pleural effusion who underwent contrast enhanced CT chest at the radiodiagnosis department in Ain Shams University Hospitals, the nature of which was proven by cytology or biopsy. An acceptance from the ethical committee of the Radiology Department and the ethical committee of Faculty of Medicine - Ain Shams University was attained to utilize the data stored on PACs system with the patient's consensus was yielded as to be a retrospective study.

Patients who were listed at this study affording to the following criteria: Adult patients (age >18 years old) with unilateral or bilateral pleural effusion who underwent contrast enhanced CT chest, the nature of which was proven by cytology or biopsy. Adult patients with confirmed malignancy elsewhere such as breast cancer, presented with pleural effusion, the nature of which was proven by cytology. No sex predilection. Patients should have normal kidney functions (GFR >30).

While any patient has one or more of the subsequent criteria was excluded: Presence of solid contraindications to contrast (Pregnant females, Patients with elevated kidney functions (GFR<30), patients allergic to contrast agent). Insufficient image quality as the presence of movement artifacts (respiratory motion artifacts due to deficiency of tolerance to apnea); unsatisfactory intravascular opacification; and occurrence of noise.

Study Tools and procedure: Imaging findings of the enrolled patients was obtained from the picture archiving and communications system (PACS) of the radiology department, Ain Shams university hospitals. Demographics, clinical data, laboratory, and cytology investigations of all patients were appraised after evaluation according to the CT scoring system for the final diagnosis.

Technique: CT chest with contrast. Patients' planning as follows: Patients were prerequisite to fast for at least 4 -6 hours, and normal ranges of kidney function tests was looked-for (applying serum creatinine test as a reference). Sufficient water intake was ordered before and afterwards the procedure. An 18–20-gauge cannula was introduced into the antecubital vein. The CT examination was done in the CT unit at Ain Shams university hospitals by General Electric Bright Speed Elite 16 slices CT device. The study populations were all scanned in a supine posture with their arms raised above the head. A breath-hold was requested from the patients seeking for avoidance of respiratory motion artifact. Bolus IV injection of nonionic contrast medium 1.5 ml/kg was used at a rate of 3 ml/s using injector pump followed by 40 ml saline at a rate of 4 ml/s.

Fundamental Technical protocols: Slice thickness of 0.625-1.25 mm. Scan time was: 0.5-1 second. KV: 120. mAs: 100-200. Collimation: 1.5-3 mm. Matrix size about: 768 x 768 or the largest available. FOV: 35 cm. Reconstruction algorithm: high spatial frequency. Window: lung and mediastinal window. Patient standard position: supine (routinely). Intensity of deep inspiration: take deep inspiration and hold (consistently recommended).

Image interpretation: The obtained images were then transported to the workstation where the axial cuts and multi-planar reconstructions were judged by two radiologists qualified in chest imaging who were blinded to the final diagnosis of the patients, to assess the pleural effusion and pulmonary involvement on the chest CT then calculate the score of the pleural effusion according to the scoring system established by Porcel et al, that helps differentiate malignant causes from benign etiology for pleural effusion which included: The presence of a pleural pathology (ie, nodules, mass, or focal/diffuse thickening) ≥1 cm (5 points); the incidence of hepatic focal metastases, an abdominal suspicious lesions(mass), the existence of a lung pathology like pulmonary mass or nodule ≥ 1 cm (3 points each); and the absenteeism of any pleural encysted loculations, cardiomegaly with or without pericardial fluid (2 points each). A CT score of ≥7 is supposed to assume malignancy.

Statistical Analysis:

Data were gathered, reviewed, coded and enrolled to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were offered as mean, standard deviations and ranges and median with inter-quartile range (IQR). Also, qualitative variables were presented as number and percentages. The comparison between groups concerning qualitative data was done by using **Chi-square test** and/or **Fisher exact test** when the expected count in any cell was found less than 5. The comparison between two independent groups with quantitative data and parametric distribution was done by using **Independent t-test** while with non-parametric data it was done by using **Mann-Whitney test. Receiver operating characteristic curve**

(ROC) was used in the qualitative form to assess the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy of the CT score to discriminate the different etiology for benign and malignant source for pleural effusion. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: P-value > 0.05: Non significant (NS). P-value < 0.05: Significant (S). P-value < 0.01: Highly significant (HS)

Ethical Considerations:

- Informed written consent clarifying the procedure details will be obtained from participant patients prior to inclusion in the study.
- The privacy of participants and confidentiality of data will be guaranteed during the various phases of the study.
- The study was processed after approval of the Research Ethical committee with the reference number 464/2022 according to Federal Wide Assurance No. FWA 000017585, Faculty of Medicine, Ain Shams University, an acceptance was achieved to utilize the data stored on PACS.

RESULTS:

A total of 30 patients were gained for our study. Data collected from the targeted population were discarded and analyzed. Results were as follows:

The male to female ratio in our sample was 60% to 40% respectively while the patient age ranged from 24 to 74 years with mean age of 53.7 years old.

Table 1: Demographic data of the studied patients.

		No. = 30
Gender	Females	12 (40.0%)
	Males	18 (60.0%)
Age (yrs)	Mean±SD	53.77 ± 16.27
	Range	24 – 74

Table 2: Relation between pathology results and demographic data of the studied patients.

		Pathology		Test value	P-value	Sig.
		Benign	Malignant			
		No. = 13	No. = 17			
Gender	Females	7 (53.8%)	5 (29.4%)	1.833*	0.176	NS
	Males	6 (46.2%)	12 (70.6%)			
Age (yrs)	Mean±SD	48.92 ± 20.96	57.47 ± 10.81	1.452•	0.157	NS
	Range	24 – 72	35 – 74			

P>0.05: Non significant (NS); P <0.05: Significant (S); P <0.01: Highly significant (HS)
•: Independent t-test; *: Chi-square test.

The previous table shows that there was no statistically significant relation found between pathological results of the studied patients and their gender and age with p-value = 0.176 and 0.157; respectively.

Regarding the CT score points, pleural lesion ≥1 cm was positive in 14 cases and negative in 16 cases. Liver metastasis was positive in 4 cases and negative in 26 cases. Abdominal mass was positive in 2 cases and negative in 28 cases. Lung mass or nodule ≥1 cm was positive in 12 cases and negative in 18 cases. Absence of pleural loculations was positive in 22 cases and negative in 8 cases. Absence of pericardial effusion was positive in 26 cases and negative in 4 cases. Absence of cardiomegaly was positive in 23 cases and negative in 7 cases as shown in Table (3).

Table 3: CT score points among the studied patients.

		No.	%
Pleural lesion ≥ 1cm (5 points)	Negative	16	53.3%
	Positive	14	46.7%
Hepatic focal metastasis (3 points)	Negative	26	86.7%
	Positive	4	13.3%
Abdominal suspicious (mass) (3 points each)	Negative	28	93.3%
	Positive	2	6.7%
Lung pathology (mass or nodule) ≥ 1 cm (3 points)	Negative	18	60.0%
	Positive	12	40.0%
Absence of pleural encysted loculations (2 points)	Negative	8	26.7%
	Positive	22	73.3%
Absence of pericardial effusion (2 points)	Negative	4	13.3%
	Positive	26	86.7%
Absence of cardiomegaly (2 points)	Negative	7	23.3%
	Positive	23	76.7%

Regarding the CT score components, pleural lesion ≥1 cm was highly significant in predicting malignancy. Liver metastasis, abdominal suspicious lesions (mass), lung pathology (mass or nodule) ≥1 cm, and absence of cardiomegaly were significant in predicting malignancy. Absence of pleural loculations and absence of pericardial effusion were non-significant in predicting malignancy as shown in Table (4).

Table 4: Relation between pathological results of the studied patients and CT score components.

		Interpretation of the pathology				Test value	P-value	Sig.
		Benign		Malignant				
		No.	%	No.	%			
Pleural lesion ≥ 1cm (5 points)	Negative	13	100.0%	3	17.6%	20.074	0.000	HS
	Positive	0	0.0%	14	82.4%			
Hepatic focal metastasis (3 points)	Negative	13	100.0%	13	76.5%	5.629	0.030	S
	Positive	0	0.0%	4	23.5%			
Abdominal suspicious (mass) (3 points each)	Negative	13	100.0%	15	88.2%	5.539	0.041	S
	Positive	0	0.0%	2	11.8%			
Lung pathology (mass or nodule) ≥ 1 cm (3 points)	Negative	11	84.6%	7	41.2%	5.792	0.016	S
	Positive	2	15.4%	10	58.8%			
Absence of pleural encysted loculations (2 points)	Negative	3	23.1%	5	29.4%	0.151	0.697	NS
	Positive	10	76.9%	12	70.6%			
Absence of pericardial effusion (2 points)	Negative	2	15.4%	2	11.8%	0.084	0.773	NS
	Positive	11	84.6%	15	88.2%			
Absence of cardiomegaly (2 points)	Negative	6	46.2%	1	5.9%	6.679	0.010	S
	Positive	7	53.8%	16	94.1%			

P>0.05: Non significant (NS); P <0.05: Significant (S); P <0.01: Highly significant (HS) ; *: Chi-square test

Regarding the CT total score, the scores were ranging from 2 to 17 with a median score of 9. 13 patients had a total score < 7 while 17 patients had a total score of ≥ 7 as shown in Table (5).

Table 5: Interpretation of the total score among the studied patients.

Interpretation of total score	No. = 30
Mean±SD	8.87 ± 4.34
Range	2 – 17
Median (IQR)	9 (5 – 14)
< 7	13 (43.3%)
≥ 7	17 (56.7%)

Regarding the pathology of the studied patients, 17 patients had malignant pleural effusion while 13 patients had benign pleural effusion as shown in Table (6).

Table 6: Pathological report of the studied patients.

Interpretation of the pathology	No.	%
Benign	13	43.3%
Malignant	17	56.7%
Total	30	100.0%

Table 7: Final diagnosis of benign cases.

Final diagnosis of benign cases	No.	%
Parapneumonic	4	30.8%
Sepsis	3	23.1%
Heart failure	2	15.4%
Wegener's granulomatosis	1	7.7%
Systemic lupus erythematosis	1	7.7%
Chronic liver disease	1	7.7%
Rheumatoid arthritis	1	7.7%

Table 8: Final diagnosis of malignant cases.

Final diagnosis of malignant cases	No.	%
Mesothelioma	7	41.2%
Bronchogenic carcinoma	5	29.4%
Breast cancer	2	11.8%
Uterine leiomyosarcoma	1	5.9%
Hodgkin's lymphoma	1	5.9%
Metastatic of Unknown origin	1	5.9%

Regarding the CT total score, benign cases were ranging from 2 to 7 with a median score of 4. Malignant cases were ranging from 6 to 17 with a median score of 12. A total score < 7 was highly significant in predicting a benign cause. A total score ≥ 7 was highly significant in predicting malignancy as shown in Table (9).

Table 9: Relation between pathological results of the studied patients and CT total score.

Total score	Interpretation of the pathology		Test value	P-value	Sig.
	Benign	Malignant			
	No. = 13	No. = 17			
Mean±SD	4.77 ± 1.36	12 ± 2.96	-4.543•	0.000	HS
Range	2 – 7	6 – 17			
Median (IQR)	4 (4 - 6)	12 (9 - 14)			
< 7	12 (92.3%)	1 (5.9%)	22.408*	0.000	HS
≥ 7	1 (7.7%)	16 (94.1%)			

P>0.05: Non significant (NS); P <0.05: Significant (S); P <0.01: Highly significant (HS)
•: Mann-Whitney test; *: Chi-square test.

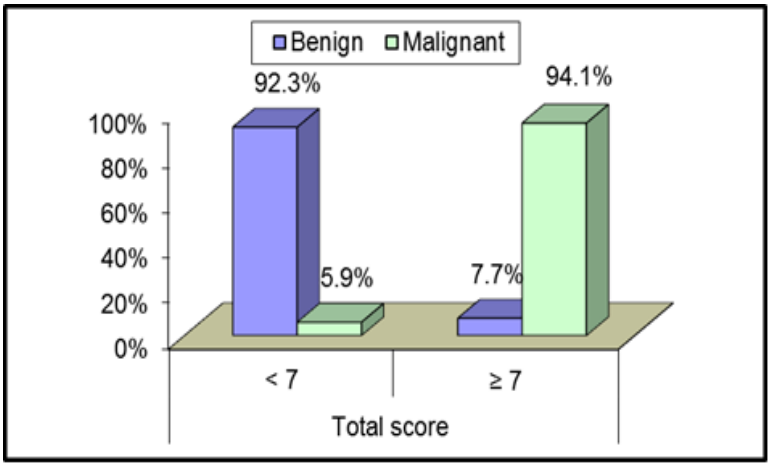
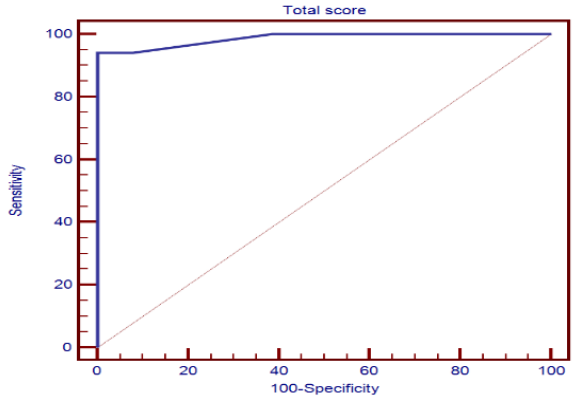
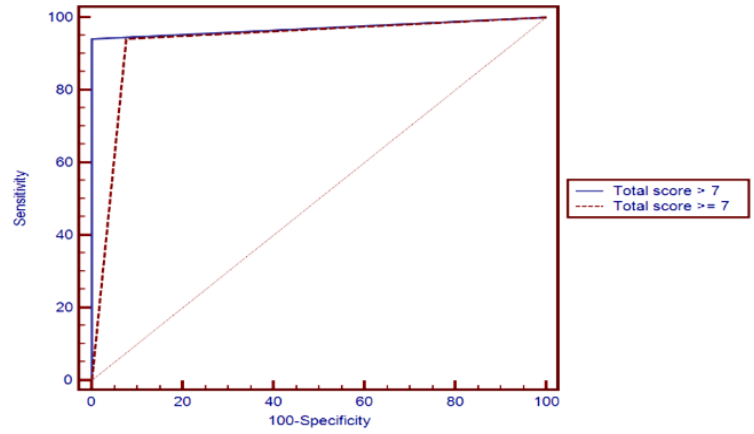


Figure 1: Relation between pathological results of the studied patients and CT total score categorization.



Cut off point	AUC	Sensitivity	Specificity	+PV	-PV
>7	0.986	94.12	100.00	100.0	92.9

Figure 2: Receiver operating characteristic curve (ROC) for the diagnostic accuracy of the total score in the differentiation between benign and malignant cases by pathology.



	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy
Total score > 7	16	13	0	1	94.1%	100.0%	100.0%	92.86%	96.67%
Total score ≥7	16	12	1	1	94.1%	92.3%	94.12%	92.31%	93.33%

Figure 3: Receiver operating characteristic curve (ROC) for the diagnostic accuracy of the total score in the differentiation between benign and malignant cases by pathology comparing the cutoff value >7 to the cutoff value ≥7.

CASES:

Case 1: 54-year-old male smoker, known diabetic developed dyspnea and tachypnea of 2 months duration.

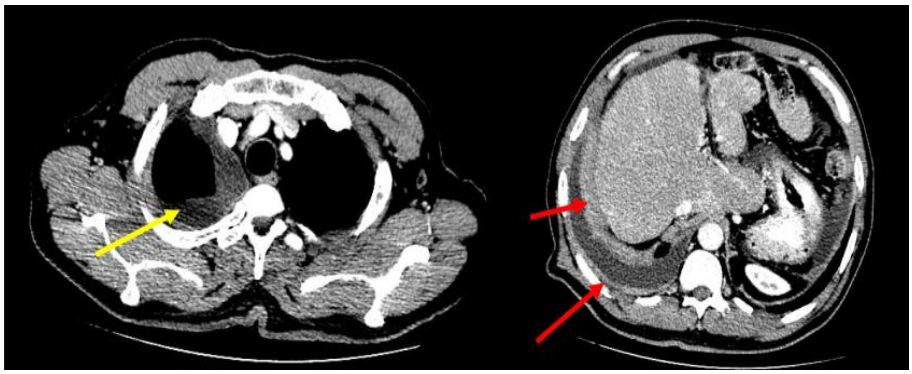


Figure 4: Moderate encysted right sided pleural effusion (yellow arrow) with enhancing thickened pleura mainly involving the diaphragmatic pleura reaching 1.4 cm maximum thickness (red arrow).

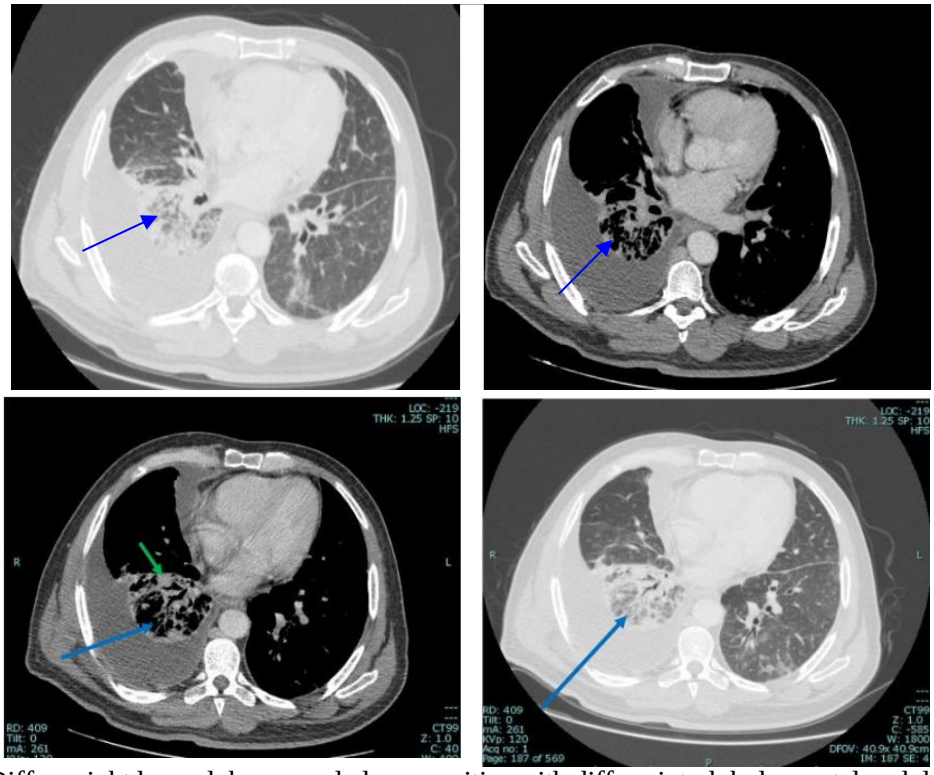


Figure 5: Diffuse right lower lobe ground glass opacities with diffuse interlobular septal nodular thickening (blue arrow). A right lower lobar nodule measuring about 3mm is seen indenting the adjacent bronchiole (green arrow)

Porcel et al CT Score:

- Pleural lesion ≥ 1cm (5 points): 5
- Hepatic focal metastasis (3 points): 0
- Abdominal suspicious lesions(mass) (3 points each): 0
- Lung pathology (mass or nodule) ≥ 1 cm (3 points): 0
- Absence of pleural encysted loculations (2 points): 0
- Absence of pericardial effusion (2 points): 2
- Absence of cardiomegaly (2 points): 2
- Total score (≥7 denotes malignancy): 9

Biopsy: Bronchogenic carcinoma (small-cell type) infiltrating the pleura.

***Case 2*:**

25-year-old male presented with progressive dyspnea and chest pain of 1-month duration

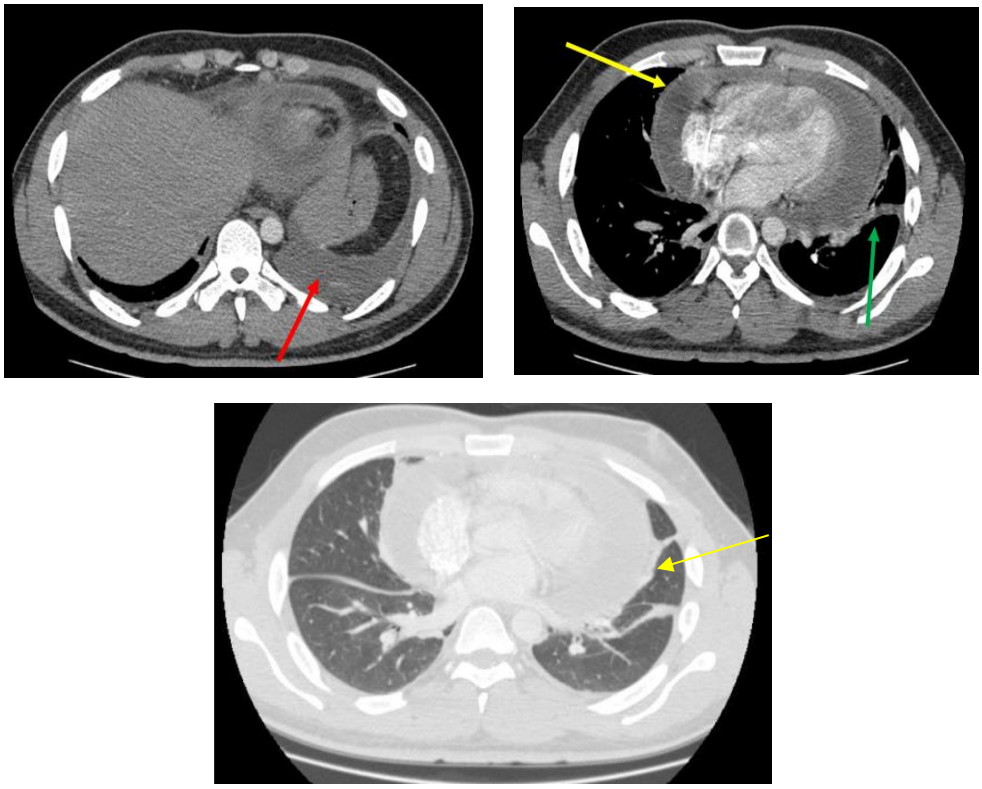


Figure 6: Mild left pleural effusion (red arrow) with fissural extension (green arrow). Massive pericardial effusion (yellow arrow).

Porcel et al CT Score:

- Pleural lesion ≥ 1cm (5 points): 0
- Hepatic focal metastasis (3 points): 0
- Abdominal suspicious lesions (mass) (3 points each): 0
- Lung pathology (mass or nodule) ≥ 1 cm (3 points): 0
- Absence of pleural encysted loculations (2 points): 2
- Absence of pericardial effusion (2 points): 0
- Absence of cardiomegaly (2 points): 2
- Total score (≥7 denotes malignancy): 4

Cytology of pleural fluid:

Exudative pleural effusion with no malignant cells.

Culture and sensitivity of pleural fluid:

No growth

The Patient was finally diagnosed with systemic lupus erythematosis with elevated serological markers like positive ANA and anti- DNA.

DISCUSSION:

Pleural effusion can be classified as either transudate or exudate. Transudate usually occurs due to a systemic cause which is mostly benign in nature while exudative effusion can occur due to either malignancy or inflammatory conditions [7]. Given that pleural effusion is a manifestation of an underlying pathology, it is crucial to search for the cause and decide whether it is a benign

or malignant one as they vary in treatment and prognosis.

The current approach that represent the gold standard to identify pleural effusion is contrast-enhanced CT scan. It helps discriminate benign from malignant source of pleural pathology. Significant indicators that pick out the presence of malignant disease including pleural focal/diffuse thickening and existence of nodular lesions**.** *Porcel et al.* estimated a CT scan scoring system which included: The existence of pleural lesions ≥ 1 cm, incidence of hepatic focal metastases, existence of lung pathology like mass or pulmonary nodule ≥ 1 cm, and the absenteeism of pleural encysted loculations, cardiomegaly with or without pericardial fluid. A CT score of ≥7 is supposed to assume malignancy with 88% sensitivity and 94% specificity [(6)].

The aim of this work was to appraise the validity and accuracy of contrast-enhanced CT chest to predict the etiology of pleural fluid whether benign or malignant using the CT-based scoring system established by *Porcel et al.* 30 adult patients with pleural effusion who experienced both pleural fluid cytology/biopsy and a contrast-enhanced chest CT scan at the radiodiagnosis department in Ain Shams University Hospitals were elaborated in this retrospective study. The study involved reviewing the contrast-enhanced CT chest of the patients and scoring them according to the *Porcel et al* CT scoring system while being blinded to the final diagnosis. The total score was then compared to the biopsy or cytology of the patients to determine its accuracy.

Regarding the demographic data among our study population, the study was conducted among 30 patients, 18 were males and 12 were females. The ages of patients ranged from 24 to 74, with mean age of 53.77. There was no statistically significant relation discovered between the pathological results of the studied populations and their gender or age with a p-value of 0.176 and 0.157; respectively. This result is different from that of *Sweed et al.* which found that patients assumed to have malignant disease were older than individuals with benign disease [(8)].

In our study, 17 (56.7%) patients had malignant pleural effusion while 13 (43.3%) patients had benign pleural effusion. The most common cause for malignant pleural effusion was mesothelioma (41.2%) followed by bronchogenic carcinoma (29.4%). These results were comparable to *Traill et al.* which also found that mesothelioma was the most common cause for malignant pleural effusion (56.25%) [(9)] while they are different from *Porcel et al.* [(6)] which found that bronchogenic carcinoma was the most common source of malignant pleural effusion (33.3%) while mesothelioma accounted only for about 3.03% of the malignant pleural effusion, and *Skok et al.* [(10)] which stated that bronchogenic carcinoma is the most common malignancy worldwide. These results reflect that mesothelioma and bronchogenic carcinoma are common causes for malignant pleural effusion. Some communities like ours have mesothelioma as the most common while others have bronchogenic carcinoma as the most common.

Also, the most common cause for benign pleural effusion in our study was parapneumonic (30.8%) which was parallel to the results of *Porcel et al.* [(6)] in which parapneumonic effusion also was the most common benign pleural effusion (56.25%).

Regarding the items of the scoring system, pleural lesion ≥1cm was highly significant in suggesting malignancy in our study as it was found in 82.4% of the malignant cases while it was not detected in any of the benign cases with a p-value of 0.00. It was also found highly significant in *Porcel et al.* (24% of malignant cases and 0.43% of benign cases) [(6)]**,** *Yilmaz et al.* [(11)] (60% of mesothelioma, 25% of metastatic pleural disease, and 6.89% of benign disease)[(11)], *Sweed et al.* (70.1% of malignant cases, and 58.3% of benign cases) [(8)]**,** and *Traill et al.*

(84.375% of malignant cases and 37.5% of benign cases) [9].

The presence of a lung mass or nodule ≥1cm was found significant in suggesting malignancy in our study as it was found in 58.8% of people with malignant source of pleural fluid and in 15.4% of who's with benign causes of pleural effusion with a p-value of 0.016. It was also found significant in *Porcel et al.* [6] (52% of malignant cases and 6.57% of benign cases), and in *Sweed et al.* [8] (44.82% of malignant cases and 5.55% of benign cases).

The absence of cardiomegaly was found significant in suggesting malignancy in our study as it was found in 94.1% of patients with malignant source of pleural fluid and 53.8% of benign causes of pleural effusion with a p-value of 0.010. It was also found significant in the results of *Porcel et al.* [6] as it was found in 86% of malignant cases (17.9% of the benign cases had cardiomegaly while 3.4% of malignant cases had cardiomegaly), yet *Sweed et al.* [8] found that cardiomegaly did not display any significant difference between both groups.

Liver metastasis (23.5% of malignant cases and none of the benign cases) and abdominal masses (11.8% of malignant cases and none of benign cases) were found significant in suggesting malignancy in our study with a p-value of 0.030 and 0.041 respectively. These results were related to those of *Porcel et al.* [6] which found that liver metastasis (14% of malignant cases, and 0.87% of benign cases) and abdominal masses (19% of malignant cases, and 0.87% of benign cases) were significant in suggesting malignancy.

The absence of pleural loculations was found non - significant in suggesting malignancy in our study as it was found in 70.6% of patients with malignant etiology for pleural effusion and 76.9% of patients with benign cause of pleural effusion with a p-value of 0.697. This result was similar to that of *Sweed et al.* [8] (14.9% of malignant cases, and 22.2% of the benign cases). However, our result was different from the result of *Porcel et al.* [6] which found that the absence of pleural loculations was significantly suggestive of malignancy as it was found in 65.2% of malignant cases and in 43.4% of the benign cases. Our study found out that some patients with malignant pleural effusion such as cases of mesothelioma, bronchogenic carcinoma, and breast cancer have pleural loculations, making it non-significant to distinguish pleural effusion etiology whether it is malignant or being benign.

The absence of pericardial effusion was found non-significant in suggesting malignancy in our study as it was found in 88.2% of the malignant cases and in 84.6% of the benign cases with a p-value of 0.773. These results were similar to those of *Sweed et al.* (3.4% of the malignant cases, and 2.8% of the benign cases**)** [8]**,** yet different from the results of *Porcel et al* [6] (98.2% of the malignant cases and 87.7% of the benign cases). This difference is likely attributed to the co-morbidities in our community as well as the presence of pericardial affection in some mesothelioma cases (the most common malignancy in our study) as mesothelial cells are also present in the pericardium.

Regarding the total score, the range of the total score of the malignant cases was 6 to 17 with a median of 12. The range of the total score of benign cases was 2 to 7 with a median of 4. The cutoff value in our study was found to be a total score >7 denoting malignancy with a sensitivity of 94.12%, a specificity of 100%, a PPV of 100, a NPV of 92.2, and AUC = 0.986. On the other hand, the cutoff value of *Porcel et al* (≥7 denotes malignancy) gave a sensitivity of 94.1%, a specificity of 92.3%, a PPV of 94.12, a NPV of 92.31, and an accuracy of 93.33% in our study. These results show that increasing the cutoff value from ≥7 to >7 increased specificity without affecting sensitivity. On the other hand, *Porcel et al.* [6] and *Sweed et*

al. [8] showed that increasing the cutoff value increased specificity yet decreased sensitivity. In *Porcel et al.* [6], the cutoff value was ≥ 7 which gave a sensitivity of 88%, a specificity of 94%, and AUC = 0.919, increasing the cutoff value to ≥ 8 or 9 increased specificity to 97% yet decreased sensitivity to 59%. In *Sweed et al.***,** the cutoff value ≥7 gave sensitivity of 70% and specificity of 66.7%, increasing the cutoff value to ≥9, increased specificity to 77.78% yet decreased sensitivity to 51.72% [8].

Unfortunately, our study has been exposed to some limitations. It could be claimed to the accuracy of the scoring system which be contingent to the occurrence of definite causes for development of pleural effusion in the participants in which it was applied.

Another potential limitation is related to the radiologic expert's interpretation. Although the radiologists were blinded to the final opinion, the valuation of the pleura might have been subjective in those patients having supplementary CT scan manifestations evocative of malignancy (e.g., hepatic focal metastases, lung pathology like (masses or nodules). Also, the need for CT scan simultaneously with pleural fluid cytology/biopsy among the inclusion criteria might seem to announce a potential selection bias, yet pleural fluid analysis/biopsy is mandatory for the final diagnosis.

Finally, the scoring system can be used as an assistance for making many different opinions for diagnosis of the etiology of pleural fluid, yet does not replace cytopathological verification of malignancy. It may be deemed as a diagnostic support to predict the likelihood of malignancy, in association with other clinical findings. Further multicentric studies assessing this CT scan score are recommended.

To conclude our work, a simple chest computed tomography scan utilizing the scoring system, which includes the estimation of pleural nodularity or focal/diffuse thickening, incidence of hepatic focal metastases, abdominal suspicious lesions (masses), lung pathology like nodules or masses, pleural encysted loculations, cardiomegaly with or without pericardial fluid, can be consistently applied for the differential diagnosis of the etiology of pleural effusions.

Conclusion:

The current study actually depicts a simple role of non-invasive wide spread modality of chest CT scan by applying a scoring system to the findings, which includes the valuation of any associated pleural nodularity or focal/diffuse thickening, incidence of hepatic metastases, abdominal masses. Underling pulmonary conditions as lung nodules or masses could be easily identified. Pleural encysted loculations, pericardial effusions, and cardiomegaly were also weighed in the scoring system. It can be constantly applied for the differential diagnosis and identifications of the etiology of pleural effusions yet does not replace pleural fluid cytology/biopsy as a requirement for verification. Further studies reviewing this CT scan score are recommended.

Conflicts of interest:

The authors have no conflicts of interest to disclose.

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Authors' contributions

AMM: main idea, data analysis and revised the manuscript.

NMH: Edited, reviewed, prepared and submitted the manuscript.

DHK: study design, follow-up of patients and collected clinical data.

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تقييم الدقة التشخيصية لنظام التسجيل المعتمد على التصوير المقطعي للصدر في التمييز بين الارتشاح البلوري الخبيث والحميد

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المقدمة: الارتشاح البلوري هو عرض للعديد من الأمراض ، لذلك من المهم البحث عن السبب وتحديد ما إذا كان حميدًا أو خبيثًا لأنه يختلف في العلاج والتشخيص والطريقة الحالية المختارة لتشخيص الارتشاح البلوري هي التصوير المقطعيبالصبغة حيث أنه يساعد في تمييز الارتشاح البلوري الخبيث من الحميدة. العلامات الهامة التي تشير إلى وجود مرض خبيث هي سماكة الغشاء البلوري. بورسيل وآخرون قام بتقييم نظام التسجيل بالأشعة المقطعية والذي تضمن: وجود آفة الغشاء البلوري> 1 سم ، النقائل في الكبد ، كتلة الرئة أو عقدة الرئة> 1 سم ، عدم وجود تجمعات للسائل البلوري ، ارتشاح التامور ، وصورة ظلية غير متضخمة للقلب. يقال إن درجة التصوير المقطعي المحوسب البالغة 7≥ تتنبأ بورم خبيث بحساسية 88٪ وخصوصية 94٪ .

الهدف من هذه الدراسة :هو تقييم دقة الاشعة المقطعية على الصدر بالصبغة للتنبؤ بطبيعة الرتشاح الرئوي سواء كان حميدًا أو خبيثًا باستخدام نظام التسجيل المعتمد على التصوير المقطعي الذي طوره بورسيل وآخرونز.

الطرق: كانت هذه دراسة بأثر رجعي تضمنت مراجعة اللأشعة المقطعية على الصدر بالصبغة وتسجيل النتائج لـ 30 مريضًا بالغًا (عمر> 18 عامًا) مصابين بالرتشاح الرئوي في قسم الأشعة التشخيصية بمستشفيات جامعة عين شمس ، وتسجيل ذلك وفقًا لنظام النقاط ثم تمت مقارنتها بعينات السائل البلوري و عينات الانسجة.

النتائج: أظهر تحليل البيانات أن العنصر ذو الأهمية العالية لنظام التسجيل المتعلق بالورم الخبيث هو سماكة الغشاء البلوري تليها كتل الرئة وغياب الارتشاح التاموري. تم العثور على قيمة القطع في دراستنا لتكون النتيجة الإجمالية > 7 تدل على وجود ورم خبيث مع حساسية 94.12٪ وخصوصية 100٪ 100 PPV و 92.2 NPV و 0.986 AUC

الخلاصة: في الختام يعد هذا نظامًا بسيطًا لتسجيل درجات التصوير المقطعي للصدر ، والذي يتضمن تقييم سماكة الغشاء البلوري ، ونقائل الكبد ، وكتل البطن ، والعقيدات أو الكتل الرئوية ، وتجمعات السائل البلوري، وارتشاح التامور، وتضخم القلب·يمكن استخدامه بشكل موثوق للتشخيص االمبدأي للارتشاح الرئوي ولكنه لا يحل محل عينة السائل البلوري / الخزعة. يوصى بإجراء مزيد من الدراسات لتقييم دقة هذا النظام.