Value of chest ultrasound for assesment of Malignant Pleural Effusion

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Abstract

Background: Pleural effusion is a common and increasing problem, however, its diagnosis remains a challenge due to its diverse etiologies, so this research was done to assess the value of ultrasonography in differentiation between benign and malignant pleural effusion at Chest Department at Zagazig University hospitals.

Patients and Methods: This prospective cross section study was carried out at Chest department and Radiology department, Zagazig University Hospitals in the period from January 2023 till June 2023. This study included 60 patients with suspected malignant pleural effusion. Chest x-ray, CT Chest, Thoracic ultrasound, were performed for all patients.

Results: Chest X ray findings revealed that 66.7% of patients had right-side lesion and 31.7% had massive effusion. CT findings revealed that 31.7% had massive effusion, 65% had pleural thickening, three patients had hilar mass, one patient had pulmonary nodule and one patient had cavity lesion. Four patients had mediastinal lymphadenopathy (6.7%). Chest US examination of patients revealed that 30% had massive effusion, 21.7% had septation, 41.7% had nodule, and 41.7% had pleural thickening. US picture suggested benign nature of lesion in 48.3% of patients. Pelvi-abdominal US revealed that 55% of patients were free and 13.3% had mild hepatomegaly. Neck US revealed that 80% of patients were free and 11.7% had enlarged cervical lymphadenopathy. There is statistically **significant** relation between type of lesion and presence of septation (53.8% of patients with septation had benign lesion), and nodules. Ultrasound can diagnose malignant lesion among 29 patients out of 48 patients with confirmed malignancy with sensitivity 60.4% and benign lesion in US can rule out malignancy in 10 out of 12 patients with confirmed benign lesions with specificity 83.3%. Positive and negative predictive value were 34.5% and 93.6% respectively with overall accuracy 65%. There is highly significant difference between benign and malignant pleural effusion regarding absence of septation (by ultrasonography) as it can diagnose malignant lesion among 42 patients out of 48 patients with confirmed malignancy with sensitivity 87.5% and septation can rule out malignancy in 7 out of 12 patients with confirmed benign lesions with specificity 58.3%. Positive and negative predictive value were 89.4% and 53.9% respectively with overall accuracy 81.7%

Conclusion: Ultrasound is a simple and safe technique that can be a good tool for diagnosis of malignant pleural effusion

Keywords: Ultrasonography, Malignant Pleural Effusion

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Introduction

Pleural effusion is a common problem; however, its diagnosis remains a challenge due to its diverse etiologies. Malignant pleural effusion (MPE) is one of the leading causes of unilateral pleural effusion **(1)** and it is defined as the accumulation of a significant amount of exudate in the pleural space, accompanied by the presence of malignant cells or tumor tissue **(2)**.

Many clinical guidelines have recommended diagnostic strategies for MPE. The role of imaging techniques is firmly established in the diagnostic workup of patients with suspected MPE. Nowadays, thoracic ultrasound (TUS) is routinely used by respiratory physicians mainly for the guidance of pleural interventions to minimize complications **(3)**. Evidence also shows that TUS could provide important information on the diagnostic pathway of pleural effusion. Pleural or diaphragmatic thickening and nodularity on TUS are highly specific for malignancy and may therefore help to speed up investigation in patients with these high-risk features. However, the sonographic fluid characteristics themselves are nonspecific by the conventional TUS **(4)**.

Ultrasound is a noninvasive and inexpensive tool; therefore, it is increasingly used by physicians. Its other advantages include lack of radiation exposure and easy personal training because of easy bedside accessibility **(5).**

The international guidelines recommended ultrasound guidance when performing diagnostic thoracentesis to reduce the risk of complications. Many recent, studies have explored the utility of morphological findings of transthoracic ultrasound (TUS) as a tool for detecting MPE **(5**).

We aimed at this study to assess the value of ultrasonography in differentiation between benign and malignant pleural effusion at Chest Department at Zagazig University hospitals

Patients and Methods

The study was carried out at Chest department and Radiology department, Zagazig University Hospitals in the period from January 2023 till June 2023. It has been approved from our Institutional Research Board – IRB 10315. Moreover, patients' written consent was obtained. This study included 60 patients with suspected malignant pleural effusion. They were 28 males and 32 females with age range from (20-83 years) and their mean age 56.52 ± 16.78 years.

Full meticulous medical history was taken from the patients to determine who will be included in or excluded from our study.

Inclusion Criteria:

Patients with suspected malignant pleural effusion clinically and radiologically, for example:

1. Patients with previous history of malignancy.
2. Patients complaining from dyspnea, chest pain, hemoptysis, cough and constitutional symptoms such as fever, decreased appetite, weight loss, night sweats, restriction of daily activities. **(6).**
3. CT chest finding with pleural features indicative for malignancy such as nodular pleural thickening, mediastinal pleural thickening, parietal pleural thickening (> 1 cm) and circumferential pleural thickening. **(7).**
4. Thoracic ultrasound finding of pleural thickening exceeding 1 cm, pleural nodularity, and diaphragmatic thickening greater than 7 mm suggestive of malignancy. **(8).**
5. Massive, rapidly accumulating pleural effusion. **(9).**
6. Hemorrhagic pleural effusion. **(6).**
7. Exudative and lymphocytic pleural effusion:

according to Light's criteria **(10)**, pleural fluid was considered as an exudate if one or more of the following criteria were met:

A. Pleural fluid protein/serum protein ≥0.5.

B. Pleural fluid LDH/serum LDH ≥0.63

C. Pleural fluid LDH more than two-thirds of the upper limit of serum LDH.

MPE commonly exhibits exudative features with a net predominance of mononuclear cells **(11).**

Exclusion Criteria:

There is no absolute contraindication for thoracic ultrasound (TUS), However, there are situations where special precautions should be taken.

1. Presence of chest drains, or dressings as this may degrade the image quality of thoracic ultrasonography. **(12)**
2. Patients who are morbidly obese as this will make the technique more difficult and less accurate. **(13)**
3. Patients who are in respiratory distress and can't hold their breath as this will make the technique less accurate **(14).**

Full meticulous medical history taking, Full clinical examination: General examination: search for signs of heart failure, renal failure or any other causes of transudative pleural effusion to be excluded. Local chest examination: for signs of pleural effusion.

laboratory investigations: Complete blood picture (CBC), Erythrocyte sedimentation rate (ESR)**.,** Prothrombin time, partial thromboplastin time and INR**,** Liver function tests (LFT), Kidney function tests (KFT), Fasting and two hours post prandial blood glucose, simultaneous with measurement of pleural fluid glucose level. Serum LDH simultaneous with measurement of pleural fluid value of LDH. Serological analysis: as serum rheumatoid factor (RF) and serum antinuclear antibody (ANA). Adenosine deaminase (ADA) was done for all patients with undiagnosed pleural effusion in the present study.

Radiological assessment by plain chest x-ray and CT chest:

Chest x-ray was performed for all patients to determine presence of any parenchymal lesions and mediastinal lymph nodes. It was abnormal in case of presence of 200 mL of pleural fluid on PA view and 50 mL on the lateral view **(15).** CT chest was done to determine features indicative for malignancy. We used a scoring system for identifying malignancy based on chest CT findings that included three elements: **(8).**

1**)** Pleural lesion greater than or equal to 1 cm (5 points)

2) Presence of liver metastasis, abdominal mass, or lung mass/nodule (3 points each)

3) Absence of pleural loculations, pericardial effusion, or cardiomegaly (2 points each)

A total score of 7 points or higher predicted MPE

Thoracic ultrasound (TUS): It was done to the patients to evaluate amount and nature of pleural fluid whether clear or turbid in real time assessment. If patients had any one of the following criteria upon TUS examination, then a TUS-based diagnosis of malignant disease was recorded:

(1) diaphragmatic or parietal pleural nodule(s).

(2) pleural thickening >1 cm; or

(3) hepatic metastasis.

If patients had none of those three criteria, benign pleural effusion based on TUS would be recorded. **(1).**

Pleural fluid aspiration: pleural fluid was aspirated from the patients and sent for full chemical, bacteriological and cytological analysis (including total and differential cell counts and cytological analysis for malignant cells) and adenosine deaminase (ADA).

Pelvi-abdominal ultrasound and neck ultrasound to exclude hepatic, renal diseases and abdominal neoplastic lesion and detect any suspected lymph nodes.

Tuberculin skin test was done for all patients. A standard dose of 5 tuberculin units (TU) (0.1 ml of PPD) is injected intradermally into the volar surface of the forearm (Mantoux method) to produce a transient wheal. The test is interpreted at 48–72 hours by measuring the transverse diameter of the palpable induration. If there is no induration, the result should be recorded as "0 mm". Erythema (redness) should not be measured **(16)**

Sputum examination: Ziehl Neelsen Stain **(**ZN) for acid fast bacilli on 3 successive days in patients who could expectorate, cytological examination for malignant cells and sputum induction was done for patients who give no sputum by hypertonic saline (3-5%).

Thoracoscopic examination of the pleural space was performed for all undiagnosed exudative pleural effusion patients in which cytology and/or pleural biopsy were not conclusive. **(17).**

Technique

Ultrasonography:

All TUS examinations were performed in the same air-conditioned room with a standardized temperature of 20°C.

Sonographic examinations were performed using a "Aplio 500 ultrasound system (Toshiba Medical Systems, Japan) with a PLT-1005BT 10 MHz linear array". The patients were in sitting position during US examination.

Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 26. Categorical variables were described using their absolute frequencies and were compared using chi square test, and Monte Carlo tests when appropriate. To compare ordinal data between two groups, chi square for trend test was used. **Kolmogorov**–**Smirnov test** was used to verify assumptions for use in parametric tests. Quantitative variables were described using their means and standard deviations or median and interquartile range according to type of data. To compare quantitative data between two groups, independents sample t test (for normally distributed data) and Mann Whitney test (for not normally distributed data) were used. ROC curve was used to determine beast cutoff of certain quantitative parameter in diagnosis of certain health problem. Validity of test was calculated using cross tabulation, from which sensitivity, specificity, positive, negative predictive values and overall accuracy were calculated. The level statistical significance was set at $P<0.05$. Highly significant difference was present if $p\leq0.001$.

Results

This study included 60 patients with age range from 20 to 83 years with mean age 56.52 years. Female represented 53.3% of patients and 55% came from rural areas. About 53% of studied patients were smokers. larger percentage (46.7%) of patients had no job (either housewives, students or retired employee). As regard clinical presentation, 98.3%, 90%, 81.7%, 43.3%, 35% and 21.7% of patients presented with dyspnea, chest pain, cough, weight loss, expectoration and fever respectively (table 1).

Table (1) Baseline and Clinical data data of studied patients

	N=60	%
Age (year) Mean ± SD Range	 56.52 ± 16.78 20 – 83	
Gender: Female Male	 32 28	 53.3% 46.7%
Residence Rural Urban	 33 27	 55% 45%
Occupation Housewife/not working	 28	 46.7%

Farmer/worker	16	26.7%
Skilled worker	2	3.3%
Employee	14	23.3%
Smoking		
Smokers	32	53.3%
Non-smoker	28	46.7%
	N=60	%
Comorbidities		
IHD	1	1.7%
Diabetes, hypertension**,** IHD	2	3.3%
Liver cirrhosis	3	5%
Cancer breast	3	5%
Diabetes, hypertension	5	8.3%
Diabetes	6	10%
Hypertension	7	11.7%
Non	33	55%
Family history		
Positive (TB)	2	3.3%
Positive (cancer breast)	2	3.3%
Negative	56	93.3%
Clinical presentation		
Dyspnea	59	98.3%
Chest pain	57	90%
Cough	49	81.7%
Weight loss	26	43.3%
Expectoration	21	35%
Fever	13	21.7%
Hemoptysis	5	8.3%

N: number, SD: standard deviation, IHD: ischemic heart diseases, TB: tuberculosis

Mean hemoglobin, total protein, serum albumin, PT, PTT and INR were 12.35 g/dl, 6.59 g/dl, 3.67 g/dl, 12.98 second, 32.07 second and 1.07 respectively. Median WBCs and platelet count were 9 and 290 (10^3/mm^3). Median SGOT and SGPT were 23.5 and 21 U/L. median creatinine, BUN and random blood glucose were 0.7, 17.5 and 495 mg/dl respectively. Median ESR in first and second hour were 88 and 52 ml/hr respectively. All patients had normal levels of rheumatoid factor and ANA. Chest X ray findings revealed that 66.7% of patients had right-side lesion and 31.7% had massive effusion. CT findings revealed that 31.7% had massive effusion, 65% had pleural thickening, three patients had hilar mass, one patient had pulmonary nodule and one patient had cavity lesion. Four patients had mediastinal lymphadenopathy (6.7%), Chest US examination of patients revealed that 30% had massive effusion, 21.7% had septation, 41.7% had nodule, and 41.7% had pleural thickening. US picture suggested benign nature of lesion in 48.3% of patients (Table 2)

Table (2) Laboratory, Radiological data (X ray and CT chest findings), ultrasound data of studied patients

	Mean ± SD	**Range**
Hemoglobin (g/dl)	12.35 ± 1.62	8.1 – 16.7
WBCs (10^3/mm^3)	9(7.3 – 10.88)¥	2.8 – 25
Platelet (10^3/mm^3)	290(213.5 – 350.5) ¥	77 – 622
Total protein (g/dl)	6.59 ± 0.73	5.5 – 8.1
Albumin (g/dl)	3.67 ± 0.45	2.6 – 4.5
Total bilirubin (g/dl)	0.5(0.33 – 0.8) ¥	2 – 4
SGPT (U/L)	23.5(17.45 – 35.95) ¥	6.2 – 45
SGOT (U/L)	21(15 – 31.75) ¥	6 – 54
Creatinine (mg/dl)	0.7(0.6 – 0.9) ¥	0.4 – 2.2
Urea (mg/dl)	17.5(12 – 23.08) ¥	6 – 37
PT (second)	12.98 ± 1.62	10 – 17.2
PTT (second)	32.07 ± 9.06	23 – 93

INR	1.07 ± 0.11	0.9 – 1.5
ESR 1st hour	88(65 – 105) ¥	27 – 140
ESR 2nd hour	52(35 – 80)	10 – 99
Random blood sugar (mg/dl)	105.5(92 – 164.5) ¥	72 – 355
Serum LDH (U/L)	495(323.5 – 838.25) ¥	94 – 5500
RF (normal)	60	100%
ANA (normal)	60	100%
X-ray	N=60	%
Side :		
Right	40	66.7%
Left	20	33.3%
Amount of effusion		
Mild	2	3.3%
Moderate	39	65%
Massive	19	31.7%
CT		
Amount of effusion		
Mild	1	1.7%
Moderate	40	66.7%
Massive	19	31.7%
Pleural thickening		
Absent	21	35%
Present	39	65%
Lung parenchyma		
NAD	55	91.7%
Pulmonary nodule	1	1.7%
Cavity lesion	1	1.7%
Hilar mass	3	5%
Others		
No	55	91.7%
Large anterior mediastinal mass	1	1.7%
Mediastinal lymphadenopathy	4	6.7%
Chest US	N=60	%
Amount of effusion		
Mild	1	2.7%
Moderate	41	68.3%
Massive	18	30%
Septation		
Absent	47	78.3%
Present	13	21.7%
Pleural nodule		
Absent	35	58.3%
Present	25	41.7%
Pleural thickening		
Absent	35	58.3%
Present	25	41.7%
Nature		
Benign	29	48.3%
Malignant	31	51.7%

N: number, SD: standard deviation, WBCs: white blood cells, SGPT: Serum Glutamate Pyruvate Transaminase, SGOT: serum glutamic-oxaloacetic transaminase, PT: Prothrombin Time, PTT: partial thromboplastin time, INR: international normalized ratio, ESR: erythrocyte sedimentation rate, LDH: lactate dehydrogenase, RF: rheumatoid factor, ANA: antinuclear antibody, CT: Computed tomography, NAD: no abnormality detected, US: ultrasound.

¥Data is represented as median and IQR

On cytological examination of pleural aspirate, 95% of samples were negative for malignancy. All samples were negative for adenosine deaminase (ADA) and culture and sensitivity (CS). Median TLC, LDH, glucose and protein were 1350 (10^3/mm^3), 454 U/L, 94.5 mg/dl and 4.85 g/dl. (Table 3)

Table (3) Analysis of pleural aspirate of studied patients

	N=60	%
Cytology Negative for malignancy Mesothelioma Metastatic mucoid adenocarcinoma	 57 2 1	 95% 3.3% 1.7%
ADA (-ve)	60	100%
Culture and sensitivity (-ve)	60	100%
TLC (10^3/mm^3)	1350(735 – 2075)	115 – 10000
LDH (U/L)	454(285.75 – 857.5)	96 – 3800
Glucose (mg/dl)	94.5(69.25 – 119)	3 – 329
Protein (g/dl)	4.85(4.2 – 5.3)	2.9 – 6.6

N: number, ADA: Adenosine deaminase, TLC: total Leucocyte count, LDH: lactate dehydrogenase

Chest ultrasonography was done for all patients. There is statistically significant relation between type of lesion and presence of septation (53.8% of patients with septation had benign lesion), and nodules

There is statistically non-significant relation between type of lesion and either amount of effusion, or pleural thickening (table 4).

Table (4) relation between diagnosis and ultrasonographic data of studied patients:

	Benign N=12 (%)	Malignant N=48 (%)	χ^2	p
Amount of effusion Mild Moderate Massive	 1 (100%) 9 (22%) 2 (11.1%)	 0 (0%) 32 (78%) 16 (88.9%)	2.496¥	0.114
Septation Absent Present	 5 (10.6%) 7 (53.8%)	 42 (89.4%) 6 (46.2%)	11.882	0.001**
Nodule Absent Present	 11 (31.4%) 1 (4%)	 24 (68.6%) 24 (96%)	6.857	0.01*
Pleural thickening Absent Present	 10 (28.6%) 2 (22.2%)	 25 (71.4%) 23 (98%)	3.857	0.05

χ^2Chi square test ¥Chi square for trend test **p≤0.001 is statistically highly significant

Table (5) relation between diagnosis and result of pleural fluid analysis of studied patients:

	Benign N=12 (%)	Malignant N=48 (%)	χ^2	p
Cytology: Negative for malignancy Tumor cells	 12 (21.1%) 0 (0%)	 45 (78.9%) 3 (100%)	Fisher	>0.999
	Median (IQR)	**Median (IQR)**	**Z**	**p**
Glucose	76(57.25 – 103.5)	99(70 – 123)	-1.497	0.134
Protein	4.95(4.3 – 5.6)	4.85(4.13 – 53)	-0.842	0.4
LDH	511(290.75 – 861.25)	441(281.25 – 857.5)	0	>0.999
TLC	1250(782.5 – 1863.75)	1350(722.5 – 2475)	-0.453	0.651

TLC: total Leucocyte count, LDH: lactate dehydrogenase

χ^2Chi square test Z Mann Whitney test **p≤0.001 is statistically highly significant

There is statistically non-significant relation between type of lesion and result of cytology or chemical analysis of pleural aspirate

Table (6) Performance of thoracic ultrasound (TUS) in differentiating type of lesion as confirmed by histopathological examination (HPE):

	Benign by HPE	Malignant by HPE	Total
	N=12	N=48	
Benign by TUS	10	19	29
Malignant by TUS	2	29	31

Sensitivity	Specificity	PPV	NPV	Accuracy	P
60.4%	83.3%	34.5%	93.6%	65%	<0.001**

TUS: thoracic ultrasound, HPE: histopathological examination, PPV positive predictive value, NPV negative predictive value, *p<0.05 is statistically significant, **p≤0.001 is statistically highly significant

Ultrasound can diagnose malignant lesion among 29 patients out of 48 patients with confirmed malignancy with sensitivity 60.4% and benign lesion in US can rule out malignancy in 10 out of 12 patients with confirmed benign lesions with specificity 83.3%. Positive and negative predictive value were 34.5% and 93.6% respectively with overall accuracy 65%

Discussion

Malignant pleural effusion (MPE) is defined as the presence of malignant cells in the pleural fluid. Malignant pleural effusions, that has an incidence of 150,000 new cases each year, have long been recognized as a major cause of morbidity in advanced cancer patients. The presence of MPE indicates systemic cancer dissemination and has been classified as M1a disease by the American Joint Committee on Cancer's TNM staging classification. **(18).** The daily practice of thoracic ultrasound (TUS) has enhanced the diagnosis of MPE and assisted in the improvement of pleural procedures **(19).**

This study shows the radiological data (X ray and CT chest findings) of studied patients. Most of cases (66.7 %) had right side pleural effusion. Considering the amount, most of them had moderate pleural effusion (65% using the chest x-ray & 66.7% using the CT). CT studies of patients also revealed pleural thickening in 65%, pulmonary nodule in 1.7%, cavitary lesion in 1.7% and hilar mass in 5% of the cases. With comparison to **Brun et al. (20)** study, 7.9% of their MPE cases had pleural thickening, 5.9% had pleural nodules and no cases cavitary lesions or hilar masses, our results showed the high percentage of pleural thickening in patients of this study which can be explained by the fact that most of our patients were diagnosed as mesothelioma and this is in agreement with **Bakhshayesh et al., 2016 (21)** study reported that the most common findings suggestive of malignant pleural mesothelioma (MPM) were pleural thickening (88.2%), followed by loculated effusion (58.8%) and thickening of the interlobar fissure (47.1%). So these findings can lead us to diagnose MPM.

The study shows the ultrasonographic data of our studied patients revealing Septation in 21.7%, pleural nodules in 41.7%, pleural thickening in 41.7% of the cases. US revealed mild, moderate & massive effusions in 2.7%, 68.3% and 30% of the cases respectively. Similar to our results regarding the septation, **Taymour et al. (2024) (22)** showed that 19.4% of the effusions were septated, however, only 25% of their cases had pleural thickening. 16.7% of their cases had mild effusion, 36.1 had moderate effusion and 47.2% had massive effusion.

The patients' lab results revealed mean hemoglobin, total protein, serum albumin, PT, PTT and INR of 12.35 g/dl, 6.59 g/dl, 3.67 g/dl, 12.98 second, 32.07 second and 1.07 respectively. Their median WBCs and platelet count were 9 and 290 (10^3/mm^3) respectively. Median SGOT and SGPT were 23.5 and 21 U/L respectively. Median creatinine, BUN and random blood glucose were 0.7, 17.5 and 495 mg/dl respectively. Median ESR in first and second hour were 88 and 52 ml/hr respectively. All patients had normal levels of rheumatoid factor and ANA. **Chen et al, (23)** results showed that ANA positivity in the pleural fluid could helps discriminate lupus pleuritis from pleural effusion of other aetiologies with a high NPV.

Despite the diagnosis of malignancy in most of our cases, 95% of the cytology samples' results were negative. Cytology results were conclusive in only 5% of the cases. According to **Porcel, (24)**, Cytologic analysis using a stained smear and cell block preparation is able to provide the diagnosis in about 55% of malignant effusions. The cytological examination of the pleural fluid is the first-line diagnostic test, along with biochemical analysis, especially in the suspicion of malignancy **(24).** The low sensitivity of cytology results can be explained by that most of our cases were diagnosed as mesothelioma and the reported sensitivity of cytology for malignant pleural mesothelioma (MPM) is low, ranging from 30% to 75%. This means that a significant number of cases may not be detected by cytology alone **(25).** The sensitivity and specificity also vary depending on the experience of the pathologist and the ancillary techniques used in conjunction with cytology **(26).**

The results also show that 100% of pleural fluid samples were both ADA, culture and sensitivity negative. This is despite that 13.3% of our patients' final diagnosis was Caseating epithelioid granuloma. However, this can be explained by that the pleural effusion in TB may be due to tuberculous hypersensitivity as tuberculous pleural effusion involves a complex interplay between true infection and hypersensitivity reactions to mycobacterial antigens in the pleural space. So while ADA levels are a valuable diagnostic marker for its diagnosis, there can be instances where they do not align with the diagnosis due to the diverse immunological responses involved in this condition.

The current findings clearly revealed that traditional thoracic ultrasound (TUS) can diagnose malignant lesion among 29 patients out of 48 patients with confirmed malignancy with sensitivity 60.4% and benign lesion in US can rule out malignancy in 10 out of 12 patients with confirmed benign lesions with specificity 83.3%. Positive and negative predictive values were 34.5% and 93.6% respectively with overall accuracy 65%.

In study by **Qureshi et al. (27)** conducted on 52 Patients stated that TUS is useful in differentiating malignant from benign pleural disease in patients presenting with suspected MPE and established that TUS parietal pleural thickening and nodularity have using a TUS threshold value of pleural thickening>1 cm as suggestive of malignancy, TUS has an overall sensitivity of 79%, specificity 100%, positive predictive value (PPV) 100% and negative predictive value (NPV) 73% for differentiating malignant from benign pleural disease.

The difference between **Qureshi et al. (27)** results and our results may be explained by the difference in etiology spectra of pleural effusion between European population and our population as this study was conducted in UK.

Comparing the performance of TUS in differentiating benign and malignant lesions, the relatively low sensitivity of TUS may be attributed to that the diagnosis of MPE made by TUS is based on pleural morphological criteria, such as pleural thickening and the presence of nodules, but many patients do not exhibit these specific features. So other techniques can overcome this limitation as ultrasound elastography which based on change in physical properties as pleural stiffness in diagnosis of MPE.

Notwithstanding, the study has limitations, the sample size of this single-center study was relatively small, which may have affected the sensitivity and specificity of thoracic ultrasound. Thus, further exploration should be conducted in a larger population of outpatients, and comparisons of the diagnostic yield of

ultrasound should be performed by radiologists and others to simplify diagnostic procedures. we believe that pulmonologists can use ultrasound after training.

Conclusion

Ultrasonography could be a simple and safe technique that can be a good adjuvant tool for diagnosis of malignant pleural effusion

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