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Role of Chest Ultrasound in Assessment of Different Pleural Lesions

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Abstract
Background: *Ultrasound is useful in lung and pleural evaluation due to its real-time response characteristics. Add to that, its portability, bed-side availability and absence of ionizing radiation; therefore, it is a safe technique for all patients. It can evaluate abnormalities in the peripheral lung parenchyma, pleura and chest wall. It may also be used to guide invasive procedures, such as pleural puncture, biopsy and chest tube insertion.****Aim of the Work:*** *to evaluate the role of ultrasound for diagnosis and assessment of different pleural lesions and the possibility to differentiate between benign and malignant pleural diseases.* ***Patients and methods:*** *This study was conducted on 30 patients. They were referred to radiology department at National cancer institute and Ain Shams University hospitals with different pleural lesionsbetween May and December of 2018.* ***Results:****Compared to CT scans, US is easier to perform and may better differentiate between pleural thickening and pleural effusion. Besides, it could detect very low amounts of effusion, as low as 3-5 ml of fluid. Chest ultrasound also served a role in tissue characterization through identifying morphology of growth in forms of non-uniformity of the pleura and heterogeneity of different tissues.* ***Conclusion:*** *Pleural ultrasound was a reliable tool in evaluation of different aspects of pleural growth and neoplasia, detection of the extent of spread to the chest wall and diaphragm in neoplastic lesions and predicting the nature of the pleural effusion through detecting internal echoes and septations.*
Key words: *Chest Ultrasound, Pleural Lesions*

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I. Introduction

Ultrasound is an answer to the longstanding dilemma ‘‘radiography or CT?”. Radiography is a familiar tool that lacks sensitivity that does not exceed 60–70%. CT has a high accuracy but severe drawbacks; cost (a real problem for most patients), transportation of critically ill patients, delay between CT and the resulting therapy, renal issues, anaphylactic shock and mainly high irradiation. Ultrasound has quite similar performances to CT; better detection of pleural septations and necrotic areas, and real time measurement allowing assessment of dynamic signs, lung sliding, air bronchogram and diaphragm[(1)].

Routine use of pleural ultrasonography may help hospitalists provide high-value care by reducing ancillary testing, including computerized tomography (CT) scans that expose patients to ionizing radiation, and reducing complications of thoracentesis. However, many hospitalists may not be familiar with the use of point-of-care ultrasound. The purpose of this review is to provide an overview of how point-of-care ultrasound can be utilized by hospitalists in the care of patients with pleural diseases. We review the literature on the diagnosis and evaluation of pleural diseases with ultrasound, as well as techniques to examine and drain the pleural space[(2)].

Interest in transthoracic ultrasound procedures increased after the availability of portable US equipment suitable for use at the patient’s bedside. It is possible to detect space-occupying lesions of the pleura, pleural effusion, focal or diffuse pleural thickening and subpleural lesions of the lung, even in emergency settings. Transthoracic US is useful as a guidance system for thoracentesis and peripheral lesion biopsy, where it minimizes the occurrence of pneumothorax and hemorrhage [(3)].

Progressing technology has challenged the role of pleural sonography [(4)]. Although chest computed tomography, magnetic resonance imaging and nuclear medicine are offering continuously pictures of higher resolution and accuracy, pleural ultrasound still possesses some advantages, not only when compared with the older radiographic technologies [(5)].

II. Aim of Study

The purpose of our study is to evaluate the role of ultrasound for diagnosis and assessment of different pleural lesions and the possibility to differentiate between benign and malignant pleural diseases.

Patients and methods

I- Patients:

This study involved 30 patients; 18 males (60%) and 12 females (40%). Their ages ranged from 17 – 73 years, with mean of 53.1±15.5 years.

They were referred to radiology department at National cancer institute and Ain shams university hospitals between May and December of 2018.

Patients presented with dyspnea in 24 patients (80%), chest pain in 13 patients (43.3%), cough in 8 patients (26.7%), fever in 4 patients (13.3%) and hemoptysis in 2 patients (6.7%). (Table 1).

Table (1): Patients' main complaints:

Complaint	Number Of Patients
Dyspnea	24
Chest Pain	13
Cough	8
Fever	4
Hemoptysis	2

ExclusionCriteria:

Patients with no pleural involvement, only parenchymal lung diseases.

II- Methods

All patients were subjected to:

1) Thorough clinical examination with history taking and chest examination.

2) Laboratory tests: They were selected according to the suspected disease etiology to reach a final diagnosis; e.g, sputum analysis.

3) Transthoracic Ultrasound:

***Probes**:

1- A high-resolution linear transducer of 7.5-12 MHz.

2- A convex transducer 3-5 MHz.

*** Technique:**

- Patients were instructed to sit erect with their arms raised and crossed behind their heads to extend the intercostal spaces and facilitate access. US transmission gel was used on clean, dry skin.
- The examination was performed initially using a convex (3-5 MHz) transducer, scanning both sides of the chest, starting from the costophrenic angle upward, dorsal to ventral. The transducer was placed intercostally with a perpendicular orientation. Thereafter, a linear (7.5-12 MHz) transducer was used to obtain additional information in the same manner.
- The advantage of longitudinal scan is visualization of a large part of the pleural line but is limited by the shadows caused by the ribs, which partially hide the pleural line. The oblique scan allows the study of the pleural line without any acoustic interference from the ribs, but within the limits of a single intercostal space.

4) Ultrasound findings were compared to Computed Tomography (CT)findings when available.

III. Results

Statistical analysis

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data.

Results

This study involved 30 patients; 18 males (60%) and 12 females (40%) (Fig.1). Their ages ranged from 17 – 73 years, with mean of 53.1±15.5 years (Table 2).

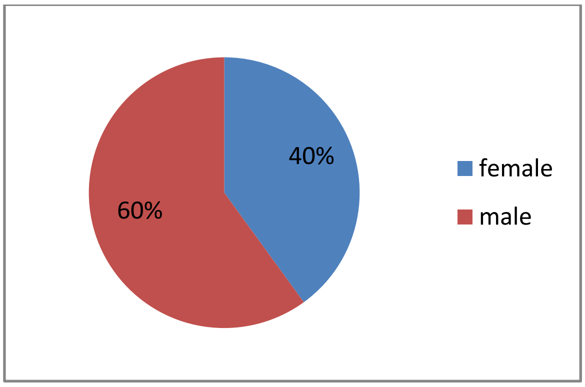


Fig.1: Demonstrating gender distributions of the patients in the study

Table 2: Age distribution of the patients participating in the study:

Age	Years
Minimum	17
Maximum	73
Mean	53.1
± SD	±15.5

The different pleural pathologies as detected by Ultrasound are 21 case of pleural effusion (70%), 10 cases of pleural thickening (33.3%) and 9 cases of pleural masses (30%) (fig.2). Pleural effusions were the most common pleural pathology encountered.

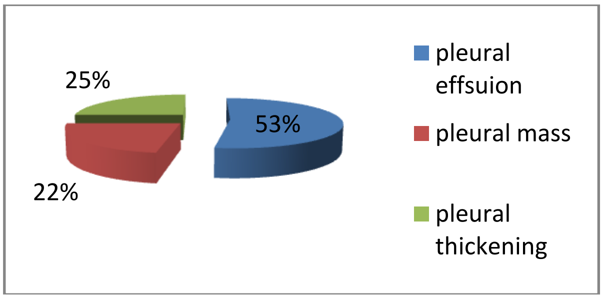


Fig.2: Demonstrating main pleural pathologies in the study

Pleural effusion

Twenty-one pleural effusions were recorded on US (70%). Table 3 describes the characteristics of pleural effusions with regard to site, loculation, volume, and echogenicity as seen on chest US.

Sixteen effusions were exudative (53.5%) and five effusions were transudative (16.7%). The chest US prediction of the nature of the pleural effusion (transudative or exudative) was in agreement with the true nature of the effusion in 61.9% of the pleural effusions that were chemically analyzed.

Table 3: Characteristics of pleural effusion as detected by ultrasonography

Characteristics	Count	%
Site		
Unilateral	16	53.3%
Bilateral	5	16.7%
Loculation		
Free	19	63.3%
Encysted	2	6.7%
Volume		
Minimal	2	6.7%
Mild	12	40.0%
Moderate	4	13.3%
Massive	3	10.0%
Echogenicity pattern		
Anechoic	13	43.3%
Complex Non-Septated	6	20.0%
Complex Septated	2	6.7%

Pleural Thickening

Ten cases of pleural thickening were recorded on US (33.3%). Six cases were metastatic deposits from different primary malignancies, showed non-uniform pleural thickening on US (20%), while the other four cases showed fairly-uniform thickening (13.3%), corresponding to 3 cases of inflammatory thickening and 1 case of 2ry lymphoma of the pleura. There was perfect agreement between the prediction of chest US of the nature of the pleural thickening (benign or malignant) and their true nature after pathological examination. (Fig. 3) (Table 4).

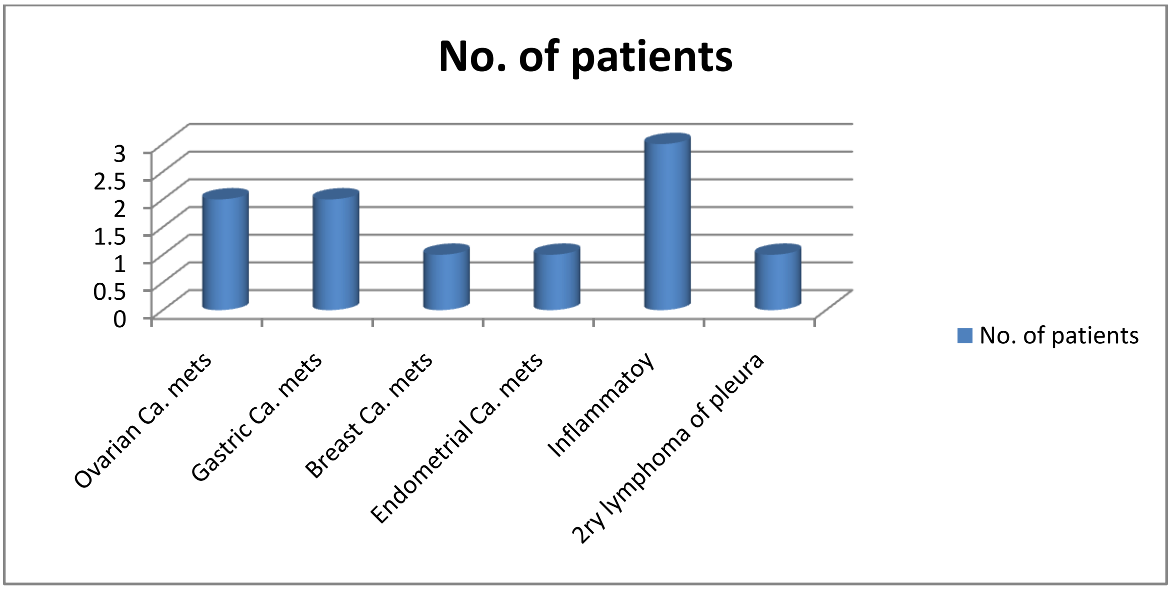


Fig.3: Pathology of pleural thickening

Table 4: Characteristics of pleural thickening as detected by ultrasonography

Characteristics	**Count**	**%**
Non-uniform	6	20.0%
Fairly uniform	4	13.3%

Pleural masses

Nine of the cases included in this study had pleural masses (30%). Table 5 describes the characteristics of pleural masses with regard to definition, heterogeneity and invasion of the surrounding structures as seen on chest US.

Eight cases were proved to be malignant (mesothelioma) (88.8%) and one case proved to be benign (fibroma) (11.1%). The chest US prediction of the nature of the pleural masses (benign or malignant) was in agreement with their true nature in 77.7% of cases that were pathologically examined. (Table 5).

Table 5: Characteristics of pleural masses as detected by ultrasonography

Characteristics	**Count**	**%**
Definition		
Well defined	3	10.0%
Ill-defined	6	20.0%
Heterogeneity		
Homogenous	1	3.3%
Heterogeneous	8	26.7%
Infiltration		
Chest Wall infiltration	4	13.3%
Mediastinal infiltration	0	0.0%

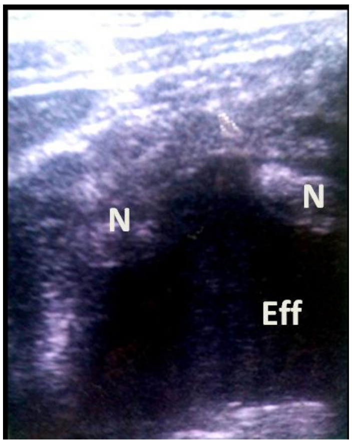
Selected cases

Case (1):

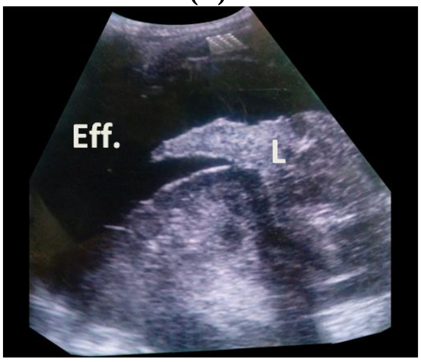
History:45-years-old female patient, with known ovarian cancer, presented with chest pain and dyspnea.

US findings: Irregular pleural thickening with multiple echogenic nodules, associated with moderate anechoic pleural effusion (Fig.4).

Final diagnosis: Metastatic deposits of ovarian cancer with hemorrhagic malignant pleural effusion.



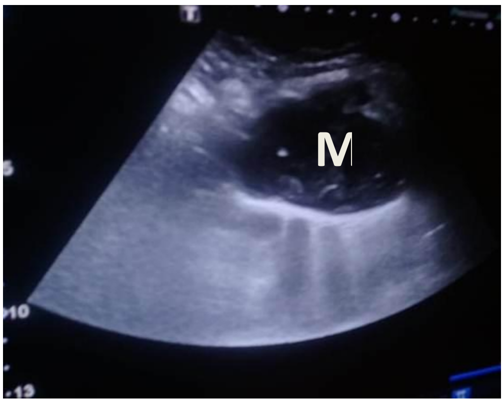
(A)



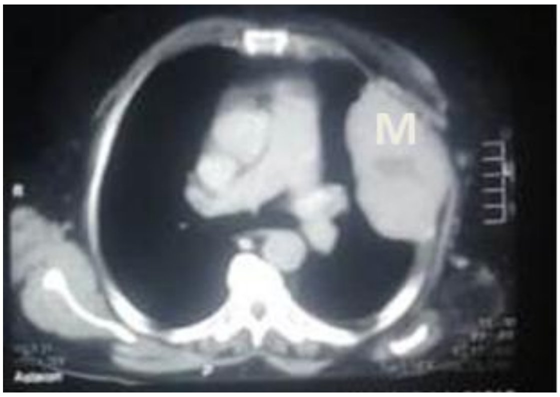
(B)

Fig.4: (A) Irregular nodular pleural thickening (N), associated with moderate anechoic pleural effusion (Eff.). (B) Moderate anechoic pleural effusion (Eff.) with underlying lung collapse (L).

Case (2):
History:70-years-old male patient, smoker, presented with chest pain and increasing dyspnea.
US findings: Left irregular heterogeneous pleural mass, infiltrating the overlying chest wall muscles and ribs, suggesting a neoplastic process (Fig.5).
CT findings: Left pleural based heterogenous soft tissue mass, invading the chest wall and related ribs (Fig.5).
Final diagnosis: Mesothelioma.



(A)



(B)

Fig.5: (A) Left irregular heterogeneous pleural mass (M), infiltrating the overlying chest wall muscles and ribs. (B) Left pleural based heterogenous soft tissue mass (M), invading the chest wall and related ribs.

IV. Discussion

Many pathological processes within the chest wall, pleurae and lungs result in profound changes in tissue composition. Inflammatory, traumatic or neoplastic processes often provide significantly improved acoustic transmission and allow adequate sonographic evaluation. Under these conditions, non-invasive, real-time ultrasound examination serves as a powerful complementary diagnostic tool with the advantage of saving time and money in addition to easy availability and the absence of complications, side effects and ionizing radiation exposure [(6)].

Chest diagnostic imaging is essential when dealing with a critically ill patient. Chest CT is the gold standard for lung imaging; however, it cannot be performed on a routine basis, as chest CT requires transporting the patients out of the intensive care unit which puts them at risk of adverse events. In addition to the transportation, the exposure to ionizing radiation carries measurable risk [(7)].

In addition to diagnostic values, ultrasound has therapeutic roles as well, such as guiding the mechanical septallysis in pleural effusion [(5)].

In this study, the final diagnosis was considered the reference standard to assess the role of ultrasound in diagnosis of different pleural lesions. Additional CT scan was done when available in some cases.
This study included 30 patients, 18 males (60%) and 12 females (40%). Their ages ranged from 17 – 73 years, with mean of 53.1±15.5 years, all had evidence of pleural disease.

Overall, the most common pleural disease detected was pleural effusion of its different types (21 cases comprising 70 % of cases) which comes in agreement with **Bediwy et al.** [(8)]who reported that pleural effusion is the most common pleural abnormality resulting from various types of diseases “inflammatory, traumatic, cardiovascular, autoimmune, metabolic and neoplastic”.

Additionally, pleural ultrasound could detect the type of pleural effusion and suggests its nature based on their internal echoes and septations in most of the cases (8 cases were exudative corresponding to complex pleural effusion and 5 cases were transudative corresponding to anechoic pleural effusion).However, in contrast to what we expect, exudative effusions can also appear as anechoic effusion as we have in 8 cases in our study, this was confirmed by **Prina et al.** [(9)].On the other hand, computed tomography, which was available for 5 cases, was unable to detect the complexity and internal septationsin the three cases of complex pleural effusion.

Furthermore, US could detect very low amounts of pleural effusion, as low as 3-5 ml of fluid, as stated by **Khosla et al.** [(10)].

Chest ultrasound served a role in tissue characterization in the 16 cases of pleural lesions (8 cases of mesothelioma, 6 cases of pleural deposits, 1 case of fibroma and 1 case of 2ry lymphoma) through identifying morphology of growth in forms of non-uniformity of the pleura, heterogeneity of different tissues and examination of the companion pleural effusion if present, findings that could be detected equally by CT, which comes in agreement with **Mayo and Doelken**[(11)].

Ultrasound was also accurate in detecting the extent of the neoplastic lesions and the invasion of the chest wall in 4 cases, similar to the available CT findings, a result that comes in agreement with **Abu-Youssef et al.** [(12)]and**Mayo and Doelken**[(11)].

However, CT was superior to US in detecting mediastinal invasion in five cases of mesothelioma. This can be attributed to the position of the lesion, being inaccessible to ultrasound. This comes in concordance with **Bediwy et al.** [(8)], which makes ultrasound reliable in assessment of different pleural lesions, unless they are related to the mediastinal pleura.

V. Conclusion

This makes pleural ultrasonography a problem solver examination in cases of anterior, posterior and diaphragmatic pleural lesions inconclusive by CT, where US can be better in detecting the site, extent and characterization of effusion.

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