Menoufia Medical Journal

PRINT ISSN: 1110-2098 - ONLINE ISSN: 2314-6788

journal hompage: www.menoufia-med-j.com

Volume 36 | Issue 3 Article 4

2023

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Recommended Citation

Arafa, Ghada Ahmed; Sultan, Hatem Mahmoud; Khamis, Ahmed Amer; Rageh, Tarek Mohey; and AbdelMohsen Eid, Hanaa (2023) "Role of Transthoracic Ultrasound in Patient with Acute Dyspnea in Emergency Department," *Menoufia Medical Journal*: Vol. 36: Iss. 3, Article 4.
DOI: https://doi.org/10.59204/2314-6788.1024

ORIGINAL STUDY

Role of Transthoracic Ultrasound in Patient with Acute Dyspnea in Emergency Department

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Abstract

Objectives: **To evaluate the role of transthoracic ultrasound in management of patients presented with acute dyspnea to the Emergency department.**

Background: **Acute dyspnea is one of the main reasons for admission to the emergency department (ED). Physicians often need to make a rapid diagnosis and a treatment plan. Although traditional methods, they remain insufficient for final diagnosis, Transthoracic ultrasonography (TUS) has been used successfully as a bedside diagnostic tool for diagnosing chest and cardiovascular diseases.**

Methods: **This prospective study was carried out on 96 patients with acute dyspnea at Emergency Department, Faculty of Medicine, Menoufia University Hospitals from May 2021 to December 2022.**

Results: **The ultrasonographic finding of studied patients with abnormal finding in 94 patients and normal in 2 patients. The accuracy of lung ultrasound (US) in relation to chest Radiography, and also in relation to (CT) according the diagnosis of pleural effusion, pneumothorax, airway diseases, lung parenchymal disease, pulmonary congestion, surgical emphysema, and fracture rib, in all of these diagnosis there was highly statistical significant ($P < 0.001$). There was a highly significant ($P < 0.001$) in comparison between traumatic and non-traumatic cases regarding findings of lung ultrasound in the following: Lung point, Lung sliding, and Barcode sign, and there was statistically significant ($P < 0.05$) in the following: B line, air bronchogram, and consolidation. No statistically significant in other TUS findings.**

Conclusion: **The TUS as an initial diagnostic tool for evaluating acute dyspnea help to find the final diagnosis and facilitating quicker decision-making.**

Keywords: Acute dyspnea, Emergency department, Transthoracic ultrasound

1. Introduction

Acute dyspnea is the sensation of difficult or uncomfortable breathing, it includes the perception of labored breathing and the patient's reaction to this sensation [1,2]. It has many causes either pulmonological (pneumonia, acute asthma exacerbation, pneumothorax and acute COPD exacerbation) or non-pulmonological (acute myocardial infarction, acute heart failure, arrhythmia and metabolic acidosis) [3].

Acute dyspnea is one of the main reasons for admission to the emergency department (ED). Physicians often need to make a rapid diagnosis and a treatment plan on the basis of limited information [4].

Although traditional methods, such as physical examination and chest Radiographys, are the most frequently used methods in the differential diagnosis of dyspnea, they remain insufficient for final diagnosis [5]. Chest computerized tomography (CT) is currently the most sensitive and feasible modality for diagnosing of many diseases, such as pneumonia, pneumothorax, pulmonary thromboembolism, and interstitial lung diseases; however, CT has significant limitations, such as exposure to ionized radiation, limited application in certain patients,

Received 3 April 2023; accepted 27 April 2023.
Available online 28 August 2023

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https://doi.org/10.59204/2314-6788.1024

such as pregnant women, the necessity of transferring a potentially unstable patient to the radiology department, and difficulty in accessing CT equipment [6].

Transthoracic ultrasonography (TUS) has been used successfully as a bedside diagnostic tool for diagnosing chest and cardiovascular diseases, especially for acute decompensated heart failure, pneumonia, pneumothorax, pulmonary thromboembolism (PTE), pleural pericardial effusion, and empyema [7]. This method has been shown to produce superior results compared with other methods, such as physical examination, chest Radiographys, and CT, in studies conducted using TUS [8].

TUS also has advantage as it can be performed at bedside, carries no risk of ionizing radiation, and can easily be implemented by emergency physicians, who can interpret findings together with other clinical signs and symptoms [9].

Several diagnoses such as pneumothorax, (no sliding sign, no B-lines, no lung pulse, lung point) pneumonia (liver like consolidation with air bronchogram) rib fractures (step in cortical bone and hematoma) pulmonary embolism (typical subpleural lesions) can be established immediately. In combination with echocardiography and leg vein compression ultrasound (triple organ ultrasound), the accuracy is more than 90% [10].

The goal of this study was to evaluate the role of transthoracic ultrasound in management of patients presented with acute dyspnea to the Emergency department.

2. Patients and methods

This study was carried out on 96 patients attending Emergency Department in Menoufia University Hospitals complaining of acute dyspnea.

The study protocol was approved by Local Ethics Committee of the Menoufia University.

The inclusion criteria was any patient above 18 years presented with acute dyspnea, while the exclusion criteria was: pregnant female, pediatric patients, patient with clear diagnosis after initial assessment (e.g., patients whose ECG shows S-T segment elevation myocardial infarction, arrythmia, patient presented with sever metabolic acidosis) and dyspnea other than chest cause.

After taking informed consent, all selected cases will undergo the following: Detailed history taking with special attention to: Previous history of chest diseases. Special habits as smoking suggesting COPD, so if those patients presenting with acute dyspnea it's most probably due to COPD exacerbation. History of bronchial asthma and family history of bronchial asthma suggesting most probably bronchial asthma exacerbation. Previous history of cardiac troubles. History of cardiac troubles mostly suggesting the event of acute dyspnea is due to cardiac cause such as pulmonary oedema, acute coronary syndrome, so detailed cardiac history was taken. History of trauma. History of trauma suggesting that the cause of dysnea is mostly pneumothorax or hemothorax, so every patient was asked about their history of trauma. History of any comorbidities. Any other medical condition related to acute dyspnea. Clinical examination: General examination: Local chest examination including: Investigations: Laboratory investigations. Routine laboratory investigation: including complete blood count, blood sugar, liver function tests, kidney function tests, and electrolytes as Na, K, Ca and Mg. Arterial blood gases. Radiological investigations: Chest x ray and C.T chest. Echocardiography if needed. Chest U/S.

Required Technical Equipment: In current study Sonoscape ultrasound machine, model S30 (Sonoscape, Shenzhen, China), was used. Two transducers used to perform TUS, Linear and convex transducers. A high frequency linear probes creates excellent image definition, but at the cost of lower tissue penetration (maximal 10 cm), in contrary the convex probe gives good penetration with less quality of the image. Investigation Procedure: Chest Wall, Pleura, Diaphragm, Lung: The investigation performed, with the patient seated, during inspiration and expiration. Raising the arms and crossing them behind the head expands the intercostal spaces and facilitates the access. The transducer is moved from ventral to dorsal along the longitudinal lines in the chest: The parasternal line. The middle clavicular line. The anterior, middle and posterior axillary line, the lateral and medial scapular line, and the paravertebral line. After application of ultrasound gel the selected probe was positioned on the chest wall perpendicular to the skin with the index marker always toward the patient's head. Anterior and posterior axillary lines divided the chest wall into three fields: Anterior, Lateral and Posterior. The fields were further divided into equal quadrants for a total of six areas on each side. The lung was scanned using Brightness (B) and Motion (M) modes.

2.1. Statistical analysis

Data were collected, tabulated and statistically analyzed using an IBM compatible personal computer with Statistical Package for the Social Sciences (SPSS) version 28 (SPSS Inc. Released 2020. IBM SPSS statistics for windows, version 28.0, Armnok, NY: IBM Corp).

3. Results

The study included 96 patients who were referred to us with acute dyspnea at emergency department to evaluate the accuracy and reliability of TUS. 95 patients had CXR, CT, and TUS, and one of them referred directly to the operating room without any other radiological investigations as mentioned previously.

Our study showed that 70 of patients were males, 26 were females and mean age was 51.98 ± 14.35 years. 52 patients (54.2%) were smokers while 44 patients (45.8%) were nonsmokers. Most of patients have systemic comorbidities (N 52) and 44 don't have systemic comorbidities, 16 patients have history of trauma (16,7%) and 80 patients don't have history of trauma (83,3%) (Fig. 1). All patients presented with acute dyspnea.

Shows the accuracy of lung ultrasound (US) in relation to chest Radiography, and also in relation to chest radiography (CXR) according the diagnosis of pleural effusion, pneumothorax, airway diseases (COPD and bronchial asthma), lung parenchymal disease (consolidation), pulmonary congestion, surgical emphysema, and fracture rib, in all of these diagnosis there was highly statistical significant ($P < 0.001$). (Table 1).

The accuracy of lung ultrasound (US) in relation to (CT) according the diagnosis of pleural effusion, pneumothorax, airway diseases (COPD and bronchial asthma), lung parenchymal disease (consolidation), pulmonary congestion, surgical emphysema, and fracture rib, in all of these diagnosis there was highly statistical significant ($P < 0.001$). (Table 2).

4. Discussion

Dyspnea is one of the common symptoms patients present to the emergency department (ED). The broad spectrum of differentials often requires laboratory and radiological testing in addition to clinical evaluation, causing unnecessary delay. Transthoracic ultrasound has shown promising results in accurately diagnosing patients with dyspnea, thus, becoming a popular tool in ED while saving time and maintaining safety standards [11].

Ultrasound (US) is a very common tool in today's clinical practice. Lung ultrasound was popularized by Daniel Lichtenstein, a French intensivist. He noted that sonographic artifacts during lung ultrasound could differentiate between various lung diseases and subsequently noted the ultrasound's ability to differentiate various diseases. He also popularized the points of probe placement and various signs and lines in lung ultrasound, which includes the A line, B-lines, Lung sliding sign, seashore sign etc [12].

Lung ultrasound has rapidly gained popularity over the past 10 years, mainly due to its wide availability in emergency and trauma settings, lack of radiation exposure, easy availability and cost effectiveness. Although there is limitation to Lung ultrasound, like being user dependent, limited role in surgical emphysema, in severely obese patients, and CT still remains a gold standard for diagnosis of lung pathologies, ultrasound has shown to be equally effective or even better in diagnosis and management of patients in critically ill patients, where obtaining CT scan or other imaging technique is not feasible.

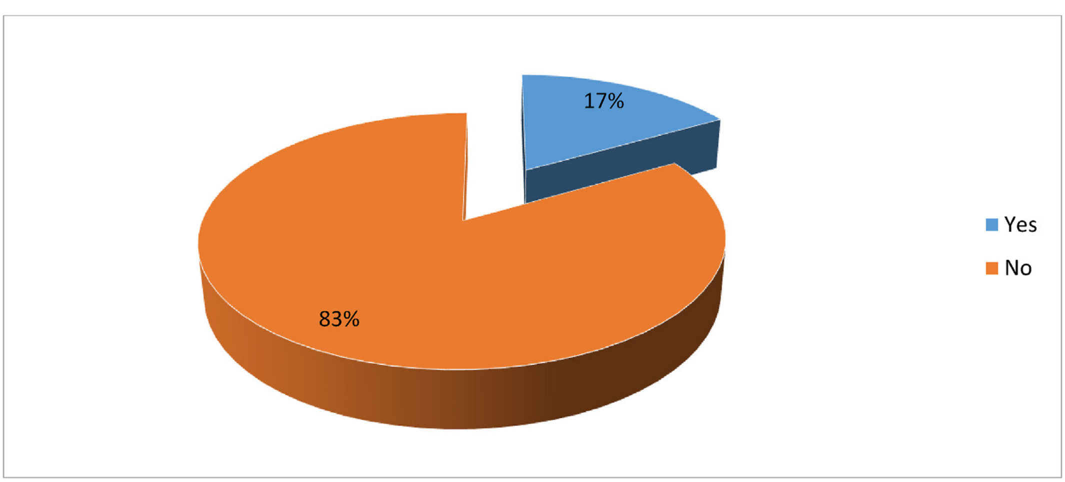

Fig. 1. History of trauma.

Table 1. Accuracy of lung ultrasound (US) in different diagnoses in relation to chest Radiography (CXR).

	Chest Radiography (CXR)			Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
	Pleural effusion		χ^2 (*P* value)					
	Yes *N* (%)	No *N* (%)						
Lung Ultrasound (US)								
Yes	30 (96.8)	15 (23.4)	45.050 (<0.001**)	96.8	76.6	66.7	98	83.2
No	1 (3.2)	49 (76.6)						
	Pneumothorax			92.3	96.3	80.0	98.8	95.8
	Yes	No	χ^2					
Yes	12 (92.3)	3 (3.7)	66.321 (<0.001**)					
No	1 (7.7)	79 (96.3)						
	Pulmonary edema (Central congestion)			100	80.7	29.2	100	82.1
	Yes	No	χ^2					
Yes	7 (100.0)	17 (19.3)	22.356 (<0.001**)					
No	0 (0.0)	71 (80.7)						
	COPD (airway disease)		χ^2	81.2	65.8	32.5	94.5	68.4
	Yes	No						
Yes	13 (81.2)	27 (34.2)	12.094 (0.001*)					
No	3 (18.8)	52 (65.8)						
	lung parenchymal disease (consolidation)		χ^2	90.0	84.7	40.9	98.6	85.3
	Yes	No						
Yes	9 (90.0)	13 (15.3)	28.061 (<0.001**)					
No	1 (10.0)	72 (84.7)						
	Surgical emphysema		χ^2	100	100	100	100	100
	Yes	No						
Yes	2 (100.0)	0 (0.0)	95.000 (<0.001**)					
No	0 (0.0)	93 (100.0)						
	Fracture rib		χ^2	50	100	100	98.9	98.9
	Yes	No						
Yes	1 (50.0)	0 (0.0)	46.990 (<0.001**)					
No	1 (50.0)	93 (100.0)						

FE, Fischer Exact test, **Highly significant ($P < 0.001$); NPV, negative predictive value; PPV, positive predictive value; χ^2, Chi square test.

Hence, lung ultrasound is a must have tool and knowledge and skills related to lung ultrasound should not only be limited to Radiologist, but also to all thoracic surgeons and physicians involved in managing critically ill patients [13].

In the present prospective study, our aim was to evaluate the role of transthoracic ultrasound in management of patients presented with acute dyspnea to the emergency department. There is a great evidence about the high diagnostic accuracy of TUS in diagnosing of acute dyspnea. Thoracic US exhibited high sensitivity and specificity in the previous studies assessed its accuracy in the diagnosis of different chest disorders [13].

CXR has a great potential in the first diagnosis of many lung disorders causing acute dyspnea and chest pain, pending the knowledge and correct interpretation of several signs. However, the physicians should be aware that the sensitivity of CXR is rather low in the diagnosis of pneumothorax, pleural effusion and pulmonary edema, particularly in bedside-acquired images [14].

In current study, Chest Radiography among the included patients shows abnormal finding in 82 patients, was normal in 13 patients, and one case didn't make CXR or CT examination only ultrasound was done and diagnosed as massive traumatic pericardial effusion as shown in Fig. 1 and was referred directly to the operating room.

In current study, according to TUS abnormal finding in 94 patients and normal in 2 patients. 45 patients (46.9%) had pleural effusion signs, 24 patient (25.0%) had multiple B-lines that indicates congestion, 40 patients (41.7%) had multiple A lines, 22 patients (22.9%) had consolidation with air bronchogram, 2 patients (2.1%) had absent color doppler, 15 patients (15.60%) had lung point and barcode sign with M mode that indicates pneumothorax, 2 patients (2.1%) had pericardial effusion and one of them referred directly to the operating room without any other radiological investigations as mentioned previously, 2 patients (2.1%) had surgical emphysema, but only one case had fracture rib by ultrasound.

Table 2. Accuracy of lung ultrasound (US) in different diagnoses in relation to computed topography (CT).

	Computed topography (CT)			Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
	Pleural effusion		χ^2 (*P*-value)					
	Yes *N* (%)	No *N* (%)						
Lung Ultrasound (US)								
Yes	43 (95.6)	2 (4.0)	79.630 (<0.001**)	95.6	96	95.6	96	95.8
No	2 (4.4)	48 (96.0)						
	Pneumothorax		FE	100	100	100	100	100
	Yes	No						
Yes	15 (88.2)	0 (0.0)	81.728 (<0.001**)					
No	2 (11.8)	78 (100.0)						
	Pulmonary edema (Central congestion)		χ^2	100	100	100	100	100
	Yes	No						
Yes	24 (100.0)	0 (0.0)	95.000 (<0.001**)					
No	0 (0.0)	71 (100.0)						
	COPD (airway disease)		χ^2	100	66.2	37.2	100	71.9
	Yes	No						
Yes	13 (81.2)	27 (34.2)	12.094 (0.001*)					
No	3 (18.8)	52 (65.8)						
	lung parenchymal disease (consolidation)		χ^2	91.7	100	100	97.3	97.9
	Yes	No						
Yes	22 (91.7)	0 (0.0)	84.697 (<0.001**)					
No	2 (8.3)	71 (100.0)						
	Surgical emphysema		χ^2	66.7	100	100	98.9	98.9
	Yes	No						
Yes	2 (66.7)	0 (0.0)	62.650 (<0.001**)					
No	1 (33.3)	92 (100.0)						
	Fracture rib		χ^2	50	100	100	98.9	98.9
	Yes	No						
Yes	1 (50.0)	0 (0.0)	46.990 (<0.001**)					
No	1 (50.0)	93 (100.0)						

FE, Fischer Exact test, **Highly significant ($P < 0.001$); NPV, negative predictive value; PPV, positive predictive value; χ^2, Chi square test.

When comprised our pervious results with study of **Agmy** et al. [14], whose study included 109 patients with acute dyspnea at Fayoum University Hospital. It was not in agreement without study in TUS results, as their patients were classified as follows: 45 (41.2%) patients had pneumonia, and 17 (15.5%) patients had pulmonary edema, eight (7.3%) patients had pneumothorax, eight (7.3%) patients had chronic obstructive pulmonary disease (COPD), five (4.5%) patients had acute severe asthma, six patients had diffuse parenchymal lung disease (DPLD), three patients had lung contusion, two patients had pulmonary embolism, and two out of three patients had acute respiratory distress syndrome (ARDS).

Classically, when pleural fluid is suspected on plain film, lateral decubitus films are required to confirm the finding. Recently, TUS was reported to accurately visualize the fluid directly, calculate the fluid volume, and identify the nature of the fluid. Thereby, further exposure to radiography radiation is avoided [15].

Lung ultrasound has long been used for identification of pleural effusions having a sensitivity above 90% **Remerand** et al. [15]. In our study pleural effusion was detected in 45 (46.8%) by TUS and 31 (32.6%) were detected by CXR. 30 patients had pleural effusion on both modalities whereas 15 cases were detected by TUS but missed on CXR. Overall, TUS picked more cases of pleural effusion. TUS diagnosed more cases of pleural effusion shows that the accuracy of lung ultrasound (US) in diagnosis of pleural effusion in relation to chest Radiography with sensitivity 96.8%, specificity 76.6%, positive predictive value 66.7%, negative predictive value 98% and accuracy 83.2%. There was statistical significant between the findings of the TUS and the CXR, $P = 0.001$.

In a study of patients with pleural effusions and decompensated heart failure, US was 90% sensitive in diagnosing a pleural effusion when compared with CT imaging, whereas CXR was 43% sensitive **Kataoka** et al. [16]. In another study that evaluated the diagnostic performance of bedside chest US and

CXR, compared with CT imaging as a gold standard, the sensitivity, specificity, and diagnostic accuracy of CXR for pleural effusion were 65%, 81%, and 69%, respectively, whereas chest US showed 100% sensitivity, specificity, and accuracy [17].

Chest US provides distinct advantages over CXR and CT imaging as clinicians have immediate access to imaging and are able to view dynamic findings of the lung. Caution must be taken as there exists a potential of missing loculated pleural effusions in nondependent areas if these areas are not examined at the time of US evaluation [17].

These results were not in agreement with the study of **Obande** et al. [17], where the Pleural effusion was detected in a total of 17 patients, of which 15 (88.2%) were detected by TUS and 11 (64.7%) were detected by CXR. Nine participants (52.9%) had pleural effusion on both modalities. Two (11.8%) cases were detected by CXR but missed on TUS, whereas 6 (35.3%) cases were detected by TUS but missed on CXR. Overall, TUS picked more cases of pleural effusion. TUS diagnosed more cases of pleural effusion. There was no significant difference between the findings of the TUS and the CXR, $P = 0.404$.

Also in **Xirouchaki** et al. [18] study the sensitivity and specificity were 100% in hemithorax analysis. Region analysis showed that all regions with false positive results ($n = 44$, usually lower lateral) were adjunct to regions (usually lower posterior) where both tests identified a pleural effusion. CXR performed very poorly (sensitivity 65%, diagnostic accuracy 69%) indicating that this technique is useless in diagnosis and evaluation of pleural effusion.

Our study showed the accuracy of lung ultrasound (US) in diagnosis of pneumothorax in relation to chest Radiography with sensitivity 92.3%, specificity 96.3%, positive predictive value 80.0%, negative predictive value 98.8% and accuracy 95.8%. While with comparison to CT sensitivity 88.2%, specificity 100%, positive predictive value 100%, negative predictive value 97.5% and accuracy 97.9%. which was with statistical significance ($P < 0.001$) in accuracy of lung ultrasound (US) in diagnosis of pneumothorax in relation to chest Radiography (CXR) and CT for our 17 cases.

Indeed, in **Xirouchaki** et al. [18] study bedside CXR did not identify any of the eight pneumothoraces transthoracic ultrasound has been successfully used for identification of pneumothorax in a variety of patients transthoracic ultrasound identified six out of the eight pneumothoraces, having a relatively low sensitivity (75%). However, both pneumothoraces missed by lung ultrasound were small and none required drainage, these finding similar to **Brook** et al. [19].

Compared to our previous results to the study of **Nagarsheth** et al. [20], who reported data of 79 patients, it did not have agreement with this study as there were 22 positive pneumothorax found by CT and of those 18 (82%) were found on ultrasound and 7 (32%) were found on chest Radiography. The sensitivity of thoracic ultrasound was found to be (81.8%) and the specificity was found to be (100%). The sensitivity of chest Radiography was found to be (31.8%) and again the specificity was found to be (100%). The negative predictive value of thoracic ultrasound for pneumothorax was 0.934 and the negative predictive value for chest Radiography for pneumothorax was found to be 0.792.

Also there was disagreement with **Alrajab** et al. [21], study has showed that the ultrasonography had a pooled sensitivity of 78.6% and a specificity of 98.4%. Chest radiography had a pooled sensitivity of 39.8% and a specificity of 99.3%.

According to accuracy of lung ultrasound (US) in diagnosis of airway diseases (COPD and bronchial asthma) in relation to chest Radiography (CXR) and CT in our 95 patients. The accuracy of lung ultrasound (US) in diagnosis of air way diseases in relation to chest Radiography with sensitivity 81.2%, specificity 65.8%, positive predictive value 32.5%, negative predictive value 94.5% and accuracy 68.4%. While with comparison to CT sensitivity 81.2%, specificity 65.8%, positive predictive value 32.5%, negative predictive value 94.5% and accuracy 68.4%, that illustrate limited value of TUS in detecting the pathological features of each of these diseases.

In concordance with these results, **Saeed** et al. [22] included 50 COPD patients with sensitivity of 86.4%, specificity of 87.5%, and accuracy of 89.5% and concluded that TUS is very sensitive, specific, and accurate parameters for weaning of COPD patients from mechanical ventilation, especially in relationship with other weaning parameters.

Accuracy of lung ultrasound (US) in diagnosis of airway diseases (COPD and bronchial asthma) in relation to chest Radiography (CXR) and CT in the current study with highly significant ($P < 0.001$).

When compared this statistical significant with **Murali** et al. [23] study, out of 53 cases included in, five patients had acute exacerbation of COPD/severe asthma and the study revealed a high concordance between ultrasound and chest Radiography ($P < 0.01$) for diagnosis.

Youssuf et al. [24], study was a prospective study carried out on 60 male participants: 40 of them were COPD patients (cases) and 20 were healthy individuals (controls). All cases were examined by transthoracic ultrasound. There was a statistically significant difference with regard to irregularity of pleura lines and prominence of A lines between COPD and control groups with a P value less than 0.001.

We use lung ultrasound (US) in diagnosis of lung parenchymal disease (consolidation) in relation to chest Radiography (CXR) and CT, showed the accuracy of lung ultrasound (US) in diagnosis of consolidation in relation to chest Radiography with sensitivity 90.0%, specificity 84.7%, positive predictive value 40.9%, negative predictive value 98.6% ‘and accuracy 85.3%. While with comparison to CT sensitivity 91.7%, specificity 100%, positive predictive value 100%, negative predictive value 97.3% and accuracy 97.9% TUS picked more cases of lung consolidation.

In comparison the sensitivity and a specificity lung ultrasound (US) in diagnosis of lung parenchymal disease (consolidation) in relation to chest Radiography (CXR) in the current study with the study of **Bloise** et al. [25]. We found that our results were different with that study as it showed that the lung ultrasound had a sensitivity of 97% and a specificity of 96% compared with CXR. This result raises questions as to why chest Radiography remains the reference standard for diagnosis in sometimes.

In the current study, there was high significant difference between the findings of the TUS and the CXR, and the TUS and the CT ($P < 0.001$). While there was no significant difference between the findings of the TUS and the CXR, $P = 0.462$ in the study of **Obande** et al. [17].

Alaa et al. [26] study was in agreement with the current study, this study revealed the detection of pneumonic consolidations by TUS with an accuracy of 87%. The agreement between TUS and CXR for consolidation was statistically significant ($P < 0.05$).

We had more accuracy of lung ultrasound (US) in diagnosis of consolidation in relation to CT when compared with **Agmy** et al. [14], that showed the accuracy of lung ultrasound (US) in diagnosis of consolidation with sensitivity 93.8%, specificity 95.7%, positive predictive value 95.6%, negative predictive value 95.8%.

In **Xirouchaki** et al. [18] study transthoracic ultrasound had a sensitivity of 100% and a diagnostic accuracy of 95% in identifying this abnormality. CXR had a much lower sensitivity (38%) and diagnostic accuracy (49%).

Chest Radiography (CXR) is the traditional first line procedure to assess pulmonary congestion, but interpretation of radiologic signs, such as vascular opacity redistribution and interstitial edema, are often questionable and subjective, while different levels of expertize of the readers may cause high inter-observer variability **Volpicelli** et al. [27].

In current study, the accuracy of lung ultrasound (US) in diagnosis of pulmonary congestion (24 patients) in relation to chest Radiography with sensitivity 100%, specificity 80.7%, positive predictive value 29.2%, negative predictive value 100% and accuracy 82.1%. While with comparison to CT sensitivity 100%, specificity 100%, positive predictive value 100%, negative predictive value 100% and accuracy 100%.

These results is not in agreement with the results of **Cardinale** et al. [28], which showed that the transthoracic ultrasound has the limitation of being a surface imaging technique far less panoramic than chest radiography and CT scan. However, the great advantages of TUS are a higher sensitivity than chest radiography in the diagnosis of the early signs of interstitial thickening due to pulmonary congestion, and the possibility to perform the examination at bedside during the first clinical approach.

The current study showed the accuracy of lung ultrasound (US) in diagnosis of surgical emphysema in relation to chest Radiography with sensitivity 100%, specificity 100%, positive predictive value 100%, negative predictive value 100% and accuracy 100%. While with comparison to CT sensitivity 66.7%, specificity 100%, positive predictive value 100%, negative predictive value 98.9% and accuracy 98.9% with high statistically significant p value < 0.001.

Our results about the of the TUS accuracy in diagnosis of surgical emphysema were different from the results of **Arthur** et al. [29] study, that enrolled 321 patients. The sensitivity and specificity

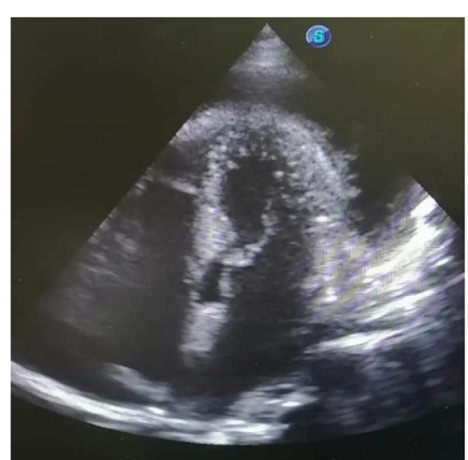

Fig. 2. Shows massive pericardial effusion by US.

Fig. 3. Show an echoic lesion (plural effusion).

of the TUS accuracy in diagnosis of surgical emphysema in relation to chest Radiography were found to be 82.5% and 78.2% respectively. A subgroup analysis including the patients in whom CT was part of the composite reference standard showed sensitivity and specificity of 87.9% and 92.9%.

In contrast to the above mentioned results of the current study. Eighty-one patients were included in **Hyacinthe** et al. [30] study. CT scans showed subcutaneous emphysema in 16 (19.8%) patients, the sensitivity and specificity of ultrasonography varied for detecting subcutaneous emphysema (56% and 95%), According to fracture rib, this study showed the accuracy of lung ultrasound (US) in diagnosis of

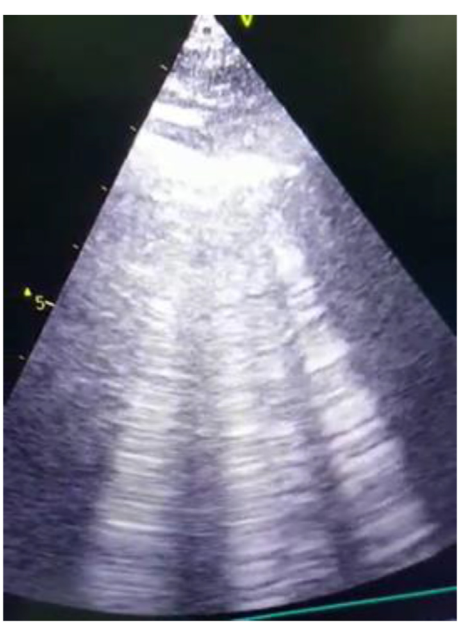

Fig. 4. Show multiple B-lines pulmonary congestion.

fracture rib in relation to chest Radiography with sensitivity 50%, specificity 100%, positive predictive value 100%, negative predictive value 98.9% and accuracy 98.9%. While with comparison to CT sensitivity 50%, specificity 100%, positive predictive value 100%, negative predictive value 98.9% and accuracy 98.9% and p value < 0.001.

Hyacinthe et al. [30] study was in agreement with the current study. CT scans showed rib fractures in 21 (25.9%), the sensitivity and specificity of ultrasonography varied for detecting rib fractures (67% and 98%).

4.1. Conclusion

The present study used TUS as a diagnostic tool for evaluating acute dyspnea patients in the emergency to improve the decision making. By combining the overall accuracy of TUS, the concordance with the final composite diagnosis, and the statistically significant reduction in time taken to formulate the diagnosis, TUS is considered an initial diagnostic tool in evaluating patients with acute dyspnea in the ED and also for facilitating quicker decision-making Figs. 2–4.

Conflicts of interest

There are no conflicts of interest.

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