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RESEARCH ARTICLE

Diagnostic value of routine usage of lung ultrasound in patients admitted to chest diseases outpatient clinic

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ABSTRACT

Diagnostic value of routine usage of lung ultrasound in patients admitted to chest diseases outpatient clinic

Introduction: *Many studies have shown that the diagnostic value of lung ultrasound is much better than chest radiography in selected patients in emergency departments, intensive care units and inpatient clinics. However, there is insufficient data on the routine use of lung ultrasonography (LUS) in chest diseases outpatient clinics. The main aim of this study was to determine the diagnostic value of routine use of AUS in outpatients.*

Materials and Methods: *One hundred and twenty-nine patients were included in the study. Lung ultrasound was performed by a pulmonologist on the same day as chest radiography (CXR), unaware of the patient's clinical and radiologic information. Chest radiographs of the patients were evaluated by two independent experts after patient recruitment was completed. The clinical final diagnosis (CFD), which was accepted as the reference standard, was obtained from hospital automation records.*

Results: *Patients were divided into two groups as those with pulmonary pathology (n= 74) and those without pulmonary pathology (n= 55) according to CFD. The sensitivity and specificity values of LUS and CXR were 48.05% and 50.64% and 78.85% and 84.62%, respectively. The rates of detection of pulmonary disease by LUS and CXR were similar (McNemar test, p> 0.05). There was moderate agreement between the two tests in assessing the presence of pulmonary pathology (kappa= 0.484, p< 0.05). Female sex and obesity negatively affected the diagnostic accuracy of LUS (p< 0.05), whereas age and symptom duration had no effect (p> 0.05). Mean LUS duration was 8.02 minutes.*

Conclusion: *The study demonstrated that LUS can contribute as a preliminary diagnostic tool with or without CXR in outpatient settings. Especially in situations where chest radiography is unavailable or contraindicated, such as pregnancy, LUS can safely contribute to the diagnosis of lung disease.*

Key words: *Outpatient clinic; routine usage; lung ultrasound; diagnosis*

ÖZ

Göğüs hastalıkları polikliniğine başvuran hastalarda toraks ultrasonografisinin rutin kullanımının tanısal değeri

Giriş: *Acil servislerde, yoğun bakımlarda ve hastaların yattığı kliniklerde seçilmiş hastalarla yapılan çalışmalarda akciğer ultrasonunun (AUS) tanısal değerinin akciğer grafisinden (CXR) çok daha iyi olduğunu gösteren pek çok araştırma vardır. Bununla birlikte göğüs hastalıkları polikliniklerinde akciğer ultrasonografisinin rutin kullanımına ilişkin yeterli veri bulunmamaktadır. Bu çalışmanın temel amacı, poliklinik hastalarında AUS'nin rutin kullanımının tanısal değerini belirlemektir.*

Materyal ve Metod: *Yüz yirmi dokuz hasta çalışmaya dahil edilmiştir. Akciğer ultrasonu, göğüs hastalıkları uzmanı tarafından hastanın klinik ve radyolojik bilgilerinden habersiz olarak CXR ile aynı gün gerçekleştirildi. Hastaların akciğer grafileri çalışmaya hasta alımı tamamlandıktan sonra bağımsız iki uzman tarafından değerlendirildi. Referans standart olarak kabul edilen klinik son tanı hastane otomasyon kayıtlarından elde edildi.*

Bulgular: *Klinik son tanıya göre pulmoner patolojisi olanlar (n= 74) ve olmayanlar (n= 55) olarak iki gruba ayrıldı. Akciğer ultrasonu ve CXR'nin duyarlılık değerleri sırasıyla %48.05 ve %50.64, özgüllük değerleri ise %78.85 ve %84.62 olarak bulunmuştur. Akciğer ultrasonu ve CXR ile akciğer hastalığı varlığını saptama oranları benzerdi (McNemar testi, p> 0.05). Pulmoner patoloji varlığını değerlendirme açısından iki test arasında orta düzeyde bir uyum vardı (kappa= 0.484, p< 0.05). Kadın cinsiyet ve obezite AUS'nin tanısal doğruluğunu olumsuz yönde etkilerken (p< 0.05) yaş ve semptom süresinin etkisi yoktu (p> 0.05). Ortalama LUS süresi 8.02 dakika idi.*

Sonuç: *Bu çalışma, AUS'nin poliklinik ortamında CXR ile birlikte veya CXR olmaksızın ön tanı aracı olarak katkıda bulunabileceğini göstermiştir. Özellikle akciğer grafisi imkanının olmadığı veya gebelik gibi nedenlerle kontrendike olduğu durumlarda, AUS akciğer hastalığının tanısına güvenle katkıda bulunabilir.*

Anahtar kelimeler: *Poliklinik; rutin kullanım; akciğer ultrasonofgrafisi; tanı*

INTRODUCTION

Physical examination is the physician's first assistant in detecting lung pathologies, especially in patients who apply to primary health care centers with respiratory complaints. Easy access to chest X-ray (CXR) and computed tomography (CT) in secondary and tertiary health centers has provided physicians with huge comfort in terms of diagnosis. Legal responsibilities, performance anxiety and increasing violence against healthcare professionals have brought along unnecessary testing demands, by ignoring radiation exposure and economic burden on patients. Failure to provide standardization in imaging methods also leads to repetitions of examinations and further increases this burden.

Ultrasonography has significant advantages such as providing real-time imaging, low cost, easy accessibility, portable usage, and no exposure to radiation and no need for contrast material (1). In recent years, studies conducted in emergency departments, intensive care units and chest diseases services have shown that lung ultrasonography (LUS) is highly successful in detecting lung pathologies such as pleural fluid, pneumothorax, consolidation and interstitial syndrome (2-13). Ultrasound has also been used successfully to assess diaphragmatic function in addition to the evaluation of the lung and pleura (14,15).

Most of the studies were conducted to demonstrate the efficacy of LUS in certain lung pathologies (16). However, to the best of our knowledge, there is no study on the routine use of LUS in outpatient clinics. The primary aim of this study was to determine the diagnostic value and routine usage of LUS in chest diseases outpatient clinics. For this purpose, the following issues were investigated: diagnostic value of LUS in detecting the presence of pulmonary pathology; the compatibility of LUS and CXR in detecting the presence of pulmonary pathology; the effects of sex, body mass index (BMI), symptom duration, and age on the diagnostic accuracy of LUS; and the time burden that LUS puts on the physician.

MATERIALS and METHODS

Ethics committee approval was obtained before the study. One hundred and twenty-nine patients, 67 males and 62 females, who applied to the Trakya University Faculty of Medicine Chest Diseases Outpatient Clinic between 04.02.2019 and 04.06.2019, were prospectively included in the study. Informed consent form was read and signed by the patients who agreed to participate in the study. Duration of the symptoms, sex, age, height, weight, BMI of the patients were recorded, and the findings of LUS were noted, and CXR was also taken on the same visit day. The patients were evaluated once a week (on Wednesday) for a period of 4 months. After the completion of the enrollment process of all patients, CXRs were interpreted by two experts who were unaware of the clinical status of the patients. Clinical final diagnosis (CFD) of the patients were obtained from hospital automation records.

Lung ultrasound

Lung US was performed on admission day by a pulmonologist with more than 10 years of LUS experience who was unaware of the patient's clinical, laboratory and radiological findings. LUS was performed using a Sonosite Micromaxx portable US device (SonoSite Inc. Bothell, WA, USA) and a 5-10 MHz linear-array probe in a separate room adjacent to the outpatient clinic where the patients applied. LUS was performed on the patient in a sitting position. It was conducted in a standard manner by dividing the lung into four parts as anterior examination, apical examination, lateral examination and posterior examination.

Anterior examination: First, the parasternal line was examined from top to bottom by placing the probe perpendicular to the ribs (longitudinal). Then, the midclavicular line was examined in the same way from top to bottom. First the anterior part of the right lung and then the anterior part of the left lung was examined.

Apical examination: First, the probe was placed in the apex region parallel to the clavicle (horizontal) and then region was examined from medial to lateral. First the right apex and then the left apex was examined.

Lateral (axillar) examination: First, the anterior axillary line was examined by placing the probe perpendicular to the ribs from top to bottom. Then, the posterior axillary line was examined in the same way from top to bottom.

Posterior examination: Initially, the probe was placed horizontally a few centimeters above the upper border of the scapula. The probe was slid from the lateral to medial along with upper border of scapula. Then it was passed to the paravertebral region. The probe was positioned perpendicular to the rib. The paravertebral line was examined up to the diaphragm level. In addition, from the lower end of the scapula to the diaphragm, it was examined perpendicular to the rib along the mid scapular line.

Consolidation, subpleural nodule, air trapping, pneumothorax, pleural effusion, pleural thickening, interstitial syndrome findings were recorded in the US recording form. LUS implementation duration was recorded as the time between the first and last contact of the probe with the patient.

The evaluation of US findings was based on the international evidence-based recommendations report on bedside LUS (17).

Chest X-ray

CXRs were taken in posteroanterior (PA) and lateral (right or left lateral) positions using the Philips Optimus 50 (Philips Medical Systems, Eindhoven, the Netherlands) device. After the patient enrollment process was completed, the evaluation of the CXR was recorded on the forms prepared separately by a pulmonologist (BSK) and a radiologist (DK), who were unaware of the identity and clinical information of the patients. Pneumothorax, pleural effusion, consolidation, and interstitial syndrome were defined according to the Fleischner Society thoracic radiology glossary (18).

Statistical evaluation

Statistical evaluation was based on the CFD. The chi-square test was used to compare the categorical values, and the t test was used to compare the parametric criteria. A value of $p< 0.05$ was accepted as the cut-off value of statistical significance. While the McNemar analysis was used to calculate whether there was a difference in the performances of the diagnostic tests, the kappa value was calculated to evaluate the compatibility of the diagnostic tests with each other and the CFD. Sensitivity, specificity, accuracy, and positive and negative predictive values of the diagnostic tests were calculated based on the CFD.

RESULTS

Demographic characteristics

A total of 129 patients, 62 females (48.1%) and 67 males (51.9%), aged between 20 and 88 years, with a mean age of 53.91 ± 14.19 years, were included in the study. Mean age of the female patients was 52.34 ± 12.5, and mean age of the male patients was 55.37 ± 15.52. There was no statistical difference between the mean ages of both sexes ($p> 0.05$).

Mean BMI of the patients was 28.1 ± 5.53 kg/m². Two patients (1.6%) were identified as underweight (BMI< 18.5), 36 patients (27.6%) were identified as normal weight (BMI= 18.5-24.9), 47 patients (36.4%) were identified as overweight (BMI= 25-29.9), 33 patients (25.6%) were identified as 1st degree obese (BMI= 30-34.9), 9 (7%) patients were identified as 2nd degree obese (BMI= 35-39.9), and 2 (1.6%) patients were identified as 3rd degree obese (BMI> 40). The duration of symptoms was one week or less in 37 (28.7%) patients, and more than one week in 92 (71.3%) patients. Descriptive characteristics of the study group are presented in Table 1.

Table 1. Descriptive characteristics of the patients

Sex	
F/M, n (%)	62 (48.1%)/67 (51.9%)
Mean age (year) ± SD (min-max)	53.91 ± 14.19 (20-88)
Mean BMI (kg/m²) ± SD (min-max)	28.1 ± 5.53 (18.9-58.8)
LUS duration	
Mean (minute) ± SD (min-max)	8.015 ± 2.375 (4.60-16.96)
Symptom duration	
≤1 week, n (%)	37 (28.7)
>1 week, n (%)	92 (71.3)

F: Female, M: Male, SD: Standard deviation, Min: Minimum, Max: Maximum, BMI: Body mass index, kg/m²: Kilogram/square meters.

It was determined that 11 patients (8.5%) included in the study were hospitalized, and 118 patients (91.5%) were followed up as outpatients.

Clinical final diagnoses

While no pathology was found in 21 of 129 patients who applied to the outpatient clinic (normal), an extra pulmonary disease was diagnosed in 34 patients (extra pulmonary pathology), and a pulmonary disease (pulmonary pathology) was diagnosed in 74 patients. The distribution of the patients according to their CFD is shown in Table 2.

Lung ultrasound

Mean LUS duration in all patients was 8.015 ± 2.375 minutes (min= 4.6, max= 16.9). Mean LUS duration was 10.01 ± 2.53 minutes (min= 5.7, max= 16.9) in patients with pulmonary pathology, and 6.81 ± 1.16 minutes (min= 4.6, max= 9.6) in patients without pulmonary pathology ($p< 0.05$).

In all of the eight patients with diagnosis of pleural effusion, pleural effusion was detected by LUS, and its sensitivity was found as 100%. Consolidation was detected by LUS in 13 (76.47%) of 17 patients who were expected to show consolidation, including eight pneumonia, seven lung cancer and two pulmonary abscess. Interstitial syndrome was detected by LUS in 8 (72.73%) of 11 patients with interstitial syndrome, 10 with DILD and one with left heart failure. Examples of cases with pleural effusion, consolidation and interstitial syndrome are shown in Figures 1, 2, 3 and 4.

Pulmonary pathology was detected with LUS in 10 of the 33 patients (30.30%) with airway or vascular pathology, including chronic obstructive pulmonary disease (COPD)/chronic bronchitis (7/12), asthma (3/18), bronchiectasis (0/2), and pulmonary hypertension (0/1).

Table 2. Clinical final diagnoses

Clinical Final Diagnoses	129
Normal	21
Extra pulmonary pathologies	34
Upper respiratory tract pathologies (n= 24)	
OSAS (n= 6)	
Cardiomegaly (n= 2)	
Larynx cancer (n= 1)	
Myocardial infarction (n= 1)	
Pulmonary pathologies	74
Asthma (n= 18)	
Chronic bronchitis/COPD (n= 12)	
DILD (n= 9)	
Pulmonary nodule (n= 9)	
Lung cancer (n= 6)*	
Pneumonia (n= 4)	
Pneumonia and pleural effusion (n= 4)	
Tuberculosis sequelae (n= 3)	
Bronchiectasis (n= 2)	
Idiopathic pleural effusion (n= 2)	
Lung abscess (n= 2)	
Lung cancer and DILD (n= 1)	
Left heart failure (n= 1)**	
Pulmonary hypertension (n= 1)	

COPD: Chronic obstructive pulmonary disease, DILD: Diffuse interstitial lung disease, OSAS: Obstructive sleep apnea syndrome.
*Pleural effusion was present in a patient with lung cancer.
**Interstitial syndrome and pleural effusion was present in a patient with left heart failure.

Pulmonary pathology was detected by LUS in only 1 of 9 patients diagnosed with pulmonary nodule (11.11%). In 2 of 3 (66.67%) patients diagnosed with tuberculosis, sequelae were found (Figure 5).

No pathology was detected by LUS in 17 of 21 (80.95%) patients who were found to be normal at the final diagnosis. In addition, no pathology was detected by lung US in 26 of 34 patients (76.47%) who were diagnosed with extra-pulmonary pathology. When patients without any pathology and patients with extrapulmonary pathology were evaluated together, it was seen that no pathology was detected by LUS in 43 (78.18%) of 55 patients without pulmonary pathology.

Pulmonary disease was detected in 37 of 48 patients with pathological findings on LUS. On the other hand, no pulmonary disease was detected in 41 of 81 patients without pathological findings on LUS.

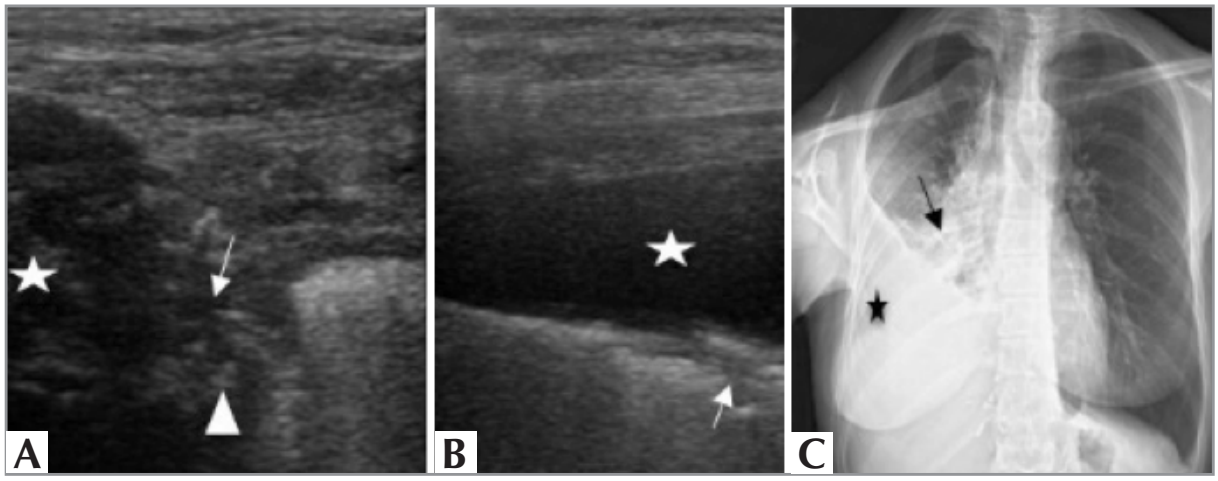


Figure 1. A patient diagnosed with parapneumonic pleural effusion, consolidation (arrow) with air bronchogram (triangle) and anechoic pleural effusion (star) were detected on lung ultrasound **(A-B)**. On chest X-ray, pleural fluid (black star) and pulmonary infiltration (black arrow) is shown **(C)**.

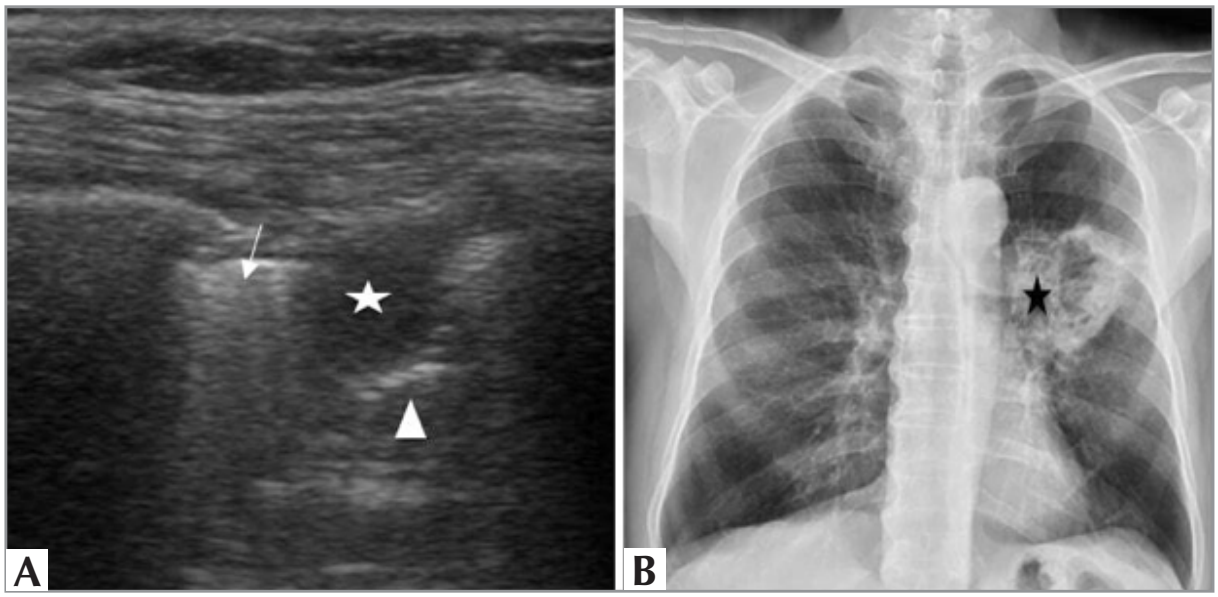


Figure 2. Lung ultrasound of a patient diagnosed with lung cancer revealed a hypoechoic mass (star) disrupting the integrity of the pleura, consolidation with air bronchogram (triangle), and B lines (arrow) extending from the pleura **(A)**. Left parahilar cavitary mass is observed on chest X-ray (black star) **(B)**.

Chest X-ray

Pathology was detected in 51 of 129 patients in the evaluation made by a chest diseases specialist, whereas pathology was detected in 48 patients in the evaluation made by a radiology specialist. The radiologist stated that there was no pathology in the X-rays of six patients whom the pulmonologist stated as pathology, and the pulmonologist stated that there was no pathology in the X-rays of three patients in whom the radiologist revealed pathology (kappa= 0.853). Consensus was reached in 6 of the 9 cases where the experts disagreed. In three cases where no consensus could be reached, the final decision was made by consulting a third specialist. As a result, pulmonary pathology was detected in 47 (36.4%) patients on CXR, whereas pulmonary pathology was not detected in 82 (63.5%) patients.

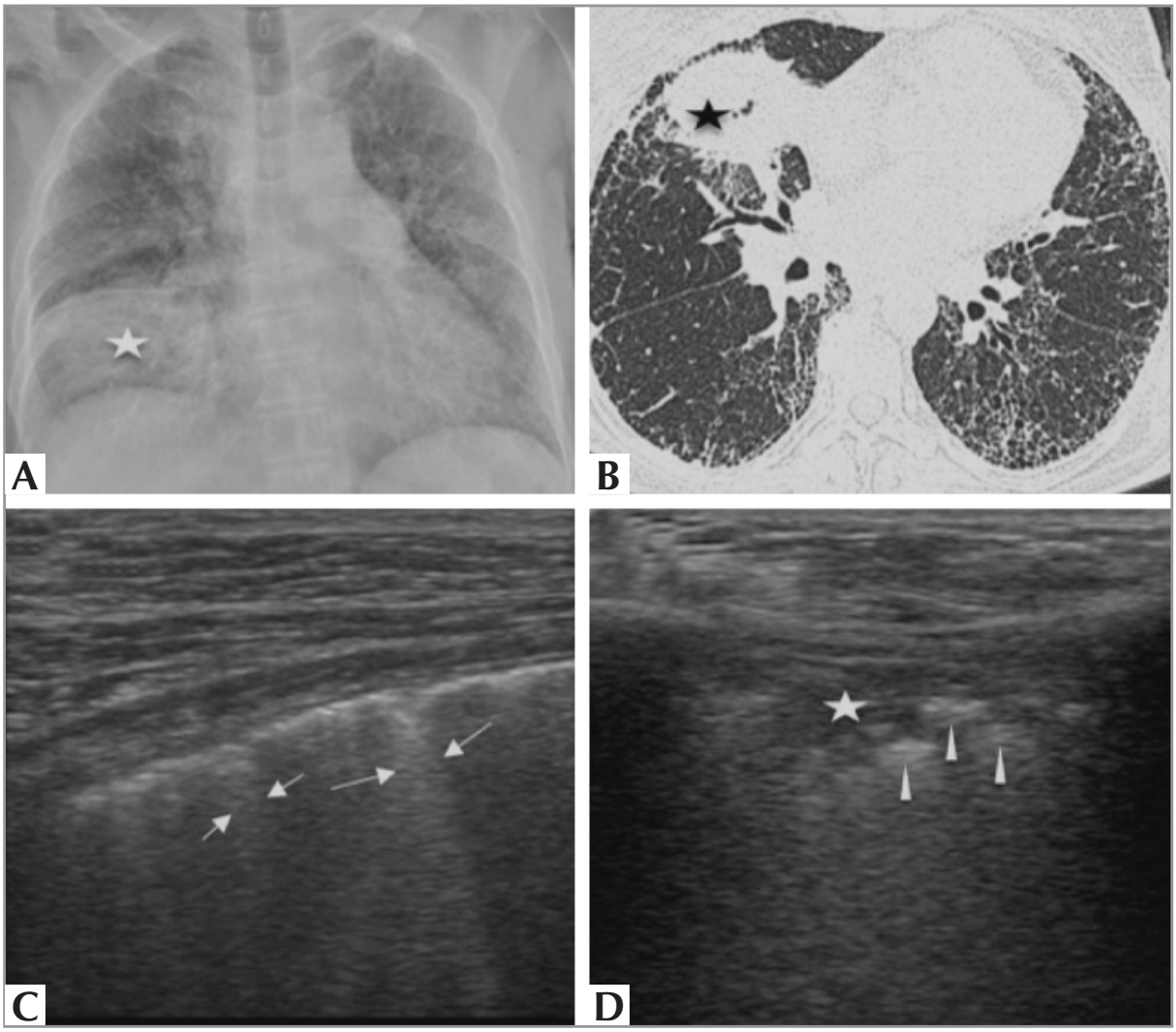


Figure 3. Diffuse interstitial involvement and consolidation (asterisk) in the lower right zone **(A)** were observed in the chest X-ray of a patient diagnosed with diffuse interstitial lung disease and lung cancer. High resolution CT image showed diffuse interstitial involvement and cavitary mass (black star) in the middle lobe (upper right) **(B)**. Lung ultrasound shows multiple B lines **(C)**. Lung ultrasound showed consolidation (star) with air bronchograms (arrow heads) **(D)**.

Pulmonary pathology was present in 39 of 47 patients with pathological findings on CXR. Pulmonary pathology was present in 38 of 82 patients without pathological findings on CXR.

Consistence between lung ultrasound and CXR

There were 98 (75.9%) cases in which LUS and CXR findings were consistent with each other and 31 (24.1%) cases in which they were inconsistent. Although US findings were normal in 15 cases (31.9%), pathology was detected by CXR and although CXR findings were normal in 16 (19.5%) cases, pathology was detected by USG. Diagnostic consistence between LUS and CXR findings was found to be significant (kappa= 0.484, p= 0.000). It was also determined that there was no significant difference between the two diagnostic methods in detecting pulmonary pathology by McNemar analysis (p> 0.05).

Consistency of lung ultrasound and CXR with the CFD

The sensitivity of LUS findings was found as 48.05%, specificity as 78.85%, positive predictive value as 77.08%, negative predictive value as 50.62%, accuracy as 66.7%, and agreement level (kappa value) as 0.247 (p= 0.02).

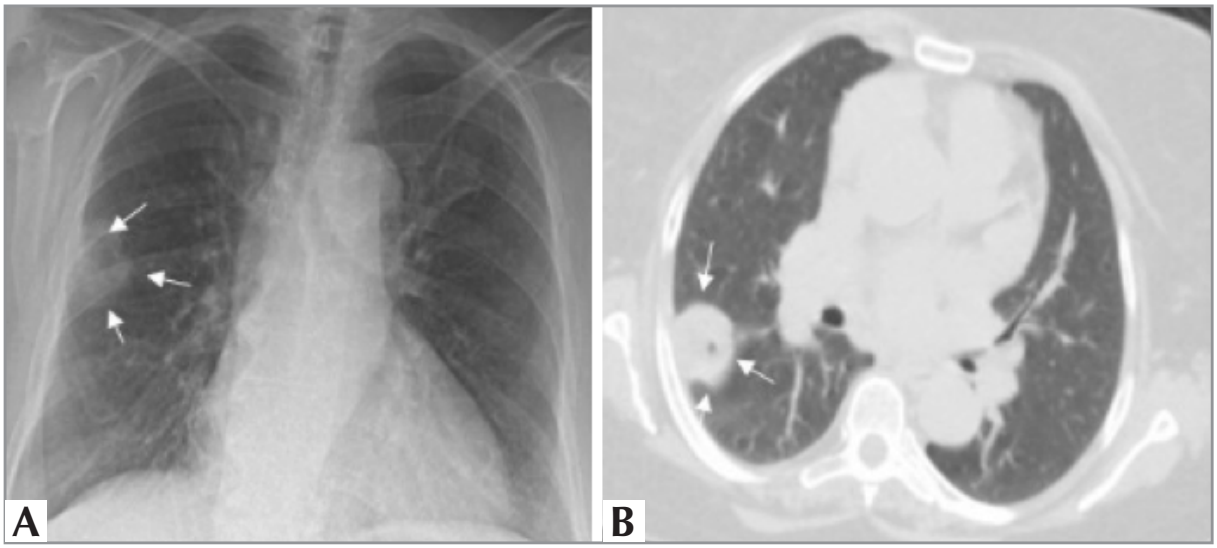


Figure 4. A cavitary mass (arrows) located in the periphery of the right middle region **(A)** was seen in the chest X-ray of an obese patient diagnosed with lung cancer. The mass just behind the scapula was underdiagnosed by LUS. A cavitary mass (arrows) in the lateral segment of the middle lobe was seen on thorax CT **(B)**.

The sensitivity of CXR findings was found as 50.64%, specificity as 84.62%, positive predictive value as 82.98%, negative predictive value as 53.66%, accuracy as 78.3%, and agreement level (kappa value) as 0.322 (p= 000). Performance results of all diagnostic tests are shown in Table 3.

The effects of sex, age, BMI and symptom duration on the diagnostic performance of lung ultrasound

LUS findings and CFD were compatible in 31 (50%) of 62 female patients, while 47 (70.15%) of 67 male patients were found to be compatible. The consistency level of LUS findings and CFD in women was statistically significantly lower than the values in men (p< 0.05). While US and CFD were consistent in 61 (61%) of 100 patients under the age of 65, LUS and CFD were consistent in 17 (58.62%) of 29 patients aged 65 and over. There was no statistically significant effect of age (≥65) on the consistency of LUS findings and CFD (p= 0.832).

Table 3. Performance results of the diagnostic tools according to the clinical final diagnosis

	LUS	CXR
Sensitivity (%)	48.05	50.64
Specificity (%)	78.85	84.62
Positive predictive value (%)	77.08	82.98
Negative predictive value (%)	50.62	53.66
Accuracy (%)	66.7	78.3

LUS: Lung ultrasound, CXR: Chest X-ray.

Lung US and CFD were consistent in 58 of 85 (68.23%) patients with BMI below 30, whereas LUS and CFD were found as consistent in 20 of 44 (45.45%) patients with BMI above 30. In patients with BMI>30, the consistency of LUS and CFD was significantly worse (p= 0.014).

Lung US and CFD were consistent in 54 of 92 (58.70%) patients with symptom duration longer than one week. No statistically significant effect of symptom duration was detected on the consistency of LUS and CFD (p= 0.556).

DISCUSSION

Studies on LUS have mostly been done in emergency departments, intensive care units or clinical wards rather than outpatient clinics. In addition, almost all of the studies have been designed to determine the effectiveness of LUS in the diagnosis of selected disease groups. The distinctive and unique aspect of our study is that it was conducted in outpatients and without patient selection.

In this study, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of LUS findings in patients admitted to the chest diseases outpatient clinic were determined as 48.05%, 78.85%, 77.08%, 50.62% and 66.70%, respectively. The diagnostic efficacy of LUS and CXR findings was similar.

Taşçı et al. have found that the sensitivity and specificity of US in detecting pneumothorax, pleural effusion, consolidation and interstitial syndrome in patients hospitalized to the clinical ward ranged from 83% to 100% for all pathologies. In addition, the efficacy of US for all pathologies has been found to be quite high when compared to CXR (5). In another study, Çakır et al. have found the sensitivity of US as 100% and specificity as 84% in patients with systemic sclerosis (19).

Winkler et al. have performed a meta-analysis covering 10 full text studies comparing thoracic CT with chest radiography and US in 545 patients hospitalized with respiratory symptoms in an intensive care unit (6). The authors have found the sensitivity and specificity of US as 95% and 94%, respectively, and sensitivity and specificity of CXR as 49% and 92%, respectively; and as a result, they recommend US as the first-choice diagnostic method for patients hospitalized in an intensive care unit.

Chiumello et al. have examined the presence of interstitial syndrome, pleural effusion and consolidation for each area by dividing each lung into six regions in patients with ARDS hospitalized in the intensive care unit (7). In their study, they have found the sensitivity values of thoracic CT and US as 82.7% and 92.3%, respectively, whereas the specificity values have been detected as 90.2% and 98.6%, respectively.

Amatya et al. have conducted a study on patients with suspected pneumonia admitted to the emergency department (8). In this study, in which thorax CT has been used as the gold standard, the authors have found the sensitivity of US 91% and CXR 73% in 44 patients diagnosed with pneumonia ($p< 0.05$).

Ye et al. have performed a meta-analysis in which they evaluated studies comparing lung US and CXR in hospitalized patients with a diagnosis of community-acquired pneumonia (9). By using thoracic CT or the final diagnosis as the golden standard, the authors have determined the sensitivity of US as 95% and specificity as 90%, while the sensitivity of CXR was 77% and the specificity was 91%. They have noted that the diagnostic accuracy of lung US is superior to that of CXR.

Nazerian et al. have performed thoracic CT and US in 285 patients who applied to the emergency department with respiratory symptoms (10). The authors have found the sensitivity of ultrasound to be 83% and the specificity to be 85% to detect consolidation. In patients with pleuritic chest pain, sensitivity increased to 92% and specificity increased to 97%. In the subgroup analysis in which 190 patients who had CXR were evaluated, the sensitivity and specificity of US were found to be 81% and 94%, respectively, while the sensitivity of the CXR was found to be 64% and the specificity as 94 percent.

Wooten et al. have compared CXR and bedside US in detecting pulmonary edema in patients admitted to the emergency department and found the sensitivity of US to be 96% and the sensitivity of CXR to be 65% ($p< 0.05$) (11). They have also detected pulmonary edema by US in 16 of 18 (89%) patients who presented no findings on CXR.

In our study, sensitivity, specificity, negative and positive predictive and diagnostic accuracy values of LUS performance was lower than the studies mentioned above. We think that the most important reason for this discrepancy was the heterogeneity of the patient population who applied to the outpatient clinic. Lung ultrasound can detect pleural or pulmonary pathologies that are in contact with the pleura by its nature. Nodules and pulmonary vascular pathologies that are not in contact with the pleura, airway pathologies such as mild COPD and asthma do not show pathological findings in LUS. Our study population had diseases that were difficult to diagnose with LUS and CXR such as airway diseases, pulmonary parenchymal nodules, and pulmonary hypertension. Another probable reason for the differences in the results of the studies mentioned above may be that pulmonary pathologies are more severe and involvements are more common in patients admitted to the emergency department and hospitalized in the intensive care unit or clinical service compared to outpatients. In our study, pulmonary pathology requiring hospitalization was found in only 11 (8.5%) of 129 patients who applied to the outpatient clinic.

In many studies performed on intensive care patients, trauma patients, and patients admitted to the emergency department, the diagnostic value of US has been found to be superior to CXR (3-5,8-10,12). In our study, unlike the others, the diagnostic accuracy of LUS was found to be statistically similar to CXR. Among the reasons for this is the fact that CXRs have been taken in the supine position and at the bedside in most of the studies mentioned above. In our study, two-sided CXRs were taken under optimal conditions.

Thorax CT is one of the most important diagnostic methods in detecting lung pathologies. The fact that CT was not performed in all patient may be seen as an important limitation of our study. We designed our research as a prospective observational study, considering that it would not be ethically appropriate to apply thoracic CT for all study patients. There were 48 patients who underwent Thorax CT examination in the hospital automation system. Some of these examinations were present at the time of presentation, and some were taken upon the request of the physician in charge of the outpatient clinic. We accepted CFD as the reference standard because findings seen on CXR or US and recorded as an ultrasonographic or radiological sign may be clinically insignificant.

We found that the concordance between LUS and CFD was negatively affected in obese patients (BMI> 30) and female patients ($p< 0.05$). Age and symptom onset time had no significant positive or negative effect on consistency ($p> 0.05$). We think that the increase in the thickness of the breast tissue and adipose tissue may impair the image quality by preventing the sound waves from reaching the lungs and complicate the optimal evaluation.

The limitations of US imaging can be listed as being dependent on the practitioner, requiring training and experience in this regard, inability to show pathologies that do not have contact with the pleura, and difficulty in visualizing the parenchyma in cases such as obesity and subcutaneous emphysema. In a study conducted by Tutino et al., the time required for the US practitioner to qualify for an ideal application and evaluation was reported as seven months (20). In our study, ultrasonography evaluation was performed by a pulmonologist with 10 years of experience. However, one of the limitations of the study is that LUS was performed and interpreted by a single specialist. Therefore, inter-rater variability for LUS findings could not be assessed.

In this study, LUS performed in outpatient setting caused an average time load of eight minutes. This period may seem long for outpatient clinics that serve a large number of patients. CXR is the most used complement to the history and physical examination for pulmonologists working in second and third level hospitals. CXR is not a real-time method, it is performed in radiology departments where special conditions are required. Although a CXR is usually taken on the same day as the examination, in some centers it may be delayed until the next day. This is a significant loss of time, especially for employees and students. Some patients need to make an appointment for repeat CXR. The physician should review the records kept by the patient and re-evaluate them together with the CXR. On the other hand, since US is a real-time examination, it can be used as a decision-making tool for the clinician together with the patient's history and physical findings. Thus, it may eliminate the need for CXR or some further tests. The most important reason for the relatively long duration of LUS in our study is that it was performed without being aware of the patient's history and physical examination. In routine practice, it seems ideal that LUS can be performed within five minutes.

In conclusion, it should be noted that, in outpatient settings, there may be potential diagnostic delays or errors resulting from reliance on LUS or CXR alone. Diagnostic investigations should always be guided by the clinical findings and risk factors of the patients. However, the study demonstrated that LUS could contribute as a preliminary diagnostic tool with or without CXR in outpatient settings. Especially in situations where chest radiography is unavailable or contraindicated, such as pregnancy, LUS can safely contribute to the diagnosis of lung disease.

Ethical Committee Approval: This study has been approved by the Scientific Research Ethics Committee of Trakya University Faculty of Medicine (Decision no: 21/11, Date: 24.12.2018).

CONFLICT of INTEREST

The authors declare that they have no conflict of interest.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: ONH, SYY

Analys/Interpretation: ONH, SYY

Data acquisition: All of authors

Writing: All of authors

Clinical Revision: All of authors

Final Approval: All of authors

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