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Diagnostic performance of trans-thoracic sonography in patients of pneumonia and pulmonary embolism

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Abstract *Background:* Trans-thoracic ultrasonography (TUS) has attracted great interest in the last few years in the diagnosis of some chest diseases that have a high mortality rate.

Objective: This study was conducted to determine the diagnostic accuracy of TUS in patients with pneumonia and pulmonary embolism. In addition, the sonomorphological changes in both diseases were studied.

Patients and methods: The study population comprised of 17 cases of pneumonia (10 males and 7 females) with a mean age of 52.02 years and 14 cases of pulmonary embolism (9 males and 5 females) with a mean age of 43.4 years. Diagnosis was based on the standard guidelines. Chest X-rays, arterial blood gases, CT chest and TUS were performed. Lung profile and other sonographic abnormalities were assessed by TUS.

Results: The sensitivities, specificities and diagnostic accuracies of TUS based on lung profile vs. CT findings were 88.2%, 87.5% and 93.5% for pneumonia, 71.4%, 80.9% and 87.1% for pulmonary embolism, respectively. Chest X-ray was diagnostic for pneumonia in 11/17 cases (sensitivity 64.7%) whereas TUS was positive in 14/17 (sensitivity 82.4%) with a significant higher area under the curve for TUS vs. chest X-ray (0.84 vs. 0.70, $P = 0.02$). 82% and 64.3% of patients with pneumonia and pulmonary embolism, respectively had abnormal parenchymal lesions with most of these lesions showing no significant difference in the two disease entities.

Conclusions: Lung profiles that can be detected using TUS can perform well to some extent as a rapid diagnostic technique among patients with pneumonia and pulmonary embolism. TUS seems to be superior to chest X-ray in the diagnosis of pneumonia. However, TUS failed to discriminate between pneumonia and pulmonary embolism on studying their parenchymal lesions.

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Introduction

Pneumonia is considered a major healthcare and economic problem with a considerable effect on morbidity and mortality worldwide [1–3]. Currently, chest radiograph (CXR) is recommended for the routine evaluation of a patient suspected of having pneumonia because medical history and physical examination cannot provide certainty in this diagnosis [4]. However, especially in the emergency department setting, CXR might have many limitations due to patient conditions, waste of time, and interobserver variability in its interpretation [5].

Computed tomography (CT), on the other hand, is considered to be the gold standard technique for the diagnosis of pneumonia, but it is often not available in some areas, has a high radiation dose, and has a high cost [6]. Because of both the clinical and the financial burdens of pneumonia, efficient and cost-effective diagnostic options for pneumonia should be considered.

Pulmonary embolism (PE) is a frequently undiagnosed and untreated disease. Because signs and symptoms are nonspecific, the diagnosis of PE may be difficult and requires a high index of suspicion. Recent technical advances, including D-dimer and computed tomographic pulmonary angiography (CTPA) have a significant effect on PE diagnosis, increasing detection rates especially for segmental PE, but not without a decrease in specificity [7,8]. Nevertheless, the interpretation of CT angiograms was incorrect or indeterminate in 9% [9] to 12% [10] of patients. In addition, complications resulting from contrast dye administration, radiation exposure and over diagnosis can occur or it may not be suitable for unstable patients who cannot tolerate transport for other imaging studies, thus, alternative methods might help physicians in some settings [11].

Previously the use of lung ultrasound (US) as a diagnostic tool was considered unjustifiable, on the grounds of conventional knowledge that lungs are filled with air, and that the US beam cannot normally pass through air-filled structures. Transthoracic ultrasound has become now an important diagnostic tool in modern chest medicine as it is a non-invasive, readily available imaging modality that can complement physical examination and clinical evaluation [12]. It can be performed at the bedside and has been used successfully to diagnose pneumothorax, pleural effusion, pneumonia, lung edema, as well as pulmonary embolism [13–15].

Aim of the work

The aim of this study was to assess the accuracy of bedside trans-thoracic ultrasonography for the diagnosis of pneumonia and pulmonary embolism. The sonographic lesions were also assessed in both diseases.

Patients and methods

Seventeen patients with pneumonia and 14 patients with pulmonary embolism were studied from those admitted at Chest Department, Assuit University Hospital during the period from October 2013–May 2014. The study protocol was approved by the Ethics Committee of Faculty of Medicine, Assiut University and informed consents were obtained from all patients.

According to American Thoracic Society guidelines [16], the suggestive clinical elements of pneumonia were cough, fever or dyspnea, sputum production, and pleuritic chest pain.

Diagnosis of pulmonary embolism was based on clinical suspicion on the basis of risk factors for venous thromboembolism (5 cases of postoperative immobilization, 2 cases of malignancy, 6 cases of previous DVT, and 1 case of nephritic syndrome), symptoms and signs of PE, such as unexplained dyspnea, chest pain, tachypnea either singly or in combination. Diagnosis was confirmed on deep vein thrombosis (DVT) that was shown by duplex sonography of lower limbs and or positive computed tomographic pulmonary angiography findings with a filling defect outlined by contrast material [17].

All the patients had been subjected to the following:

- History taking and physical examination.
- Plain chest X-ray.
- Arterial blood gases and laboratory investigations.
- Either high-resolution CT (HRCT) chest or CTPA was done according to the suspicion of diagnosis and analyzed by an independent radiologist, who was unaware of clinical findings.
- Duplex lower limbs in suspected cases of deep venous thrombosis.
- Transthoracic ultrasonography (TUS): TUS was performed in all patients using ALOKA ultrasound diagnostic equipment prosound SSD-3500 (Tokyo, Japan). TUS was done using both (2.5–5 MHz) convex probe and (7.5–10 MHz) linear probe for lung and pleura examination.

Ultrasonographic chest examination was done using grayscale (B-mode), time- motion mode (M-mode) and color doppler mode.

The following were assessed on TUS [18]:

(1) Lung sliding (the "to-and-fro" twinkling movement of the lung during respiration that was visible at the pleural line).
(2) Artifacts types and lung profiles were detected as the following:
   A profile = anterior predominant bilateral A lines (horizontal hyperechoic lines below and parallel to the pleural line and associated with lung sliding).
   A′ profile = A profile with abolished lung sliding.
   B profile = anterior predominant bilateral B lines (vertical hyperechoic lines arising from the pleural line that spread all the way to the edge of the screen without fading) associated with lung sliding.
   B′ profile = B profile with abolished lung sliding.
   A/B profile = anterior predominant B lines at one side, predominant A lines at the other.
   C profile = anterior lung consolidation.
   PLAPS = posterior-lateral alveolar consolidation and/or pleural effusion syndrome (Fig. 1)
(3) Abnormal sonographic findings of consolidation in the form of subpleural, echo-poor region or one with tissue-like echotexture, with air (dynamic hyperechogenic foci) and or fluid bronchograms (anechoic tubular structures) may be seen within the consolidated lung. Pleural effusion is seen as a homogeneous, anechoic space between the parietal and visceral pleura [19].