

Comparison the diagnostic accuracy of conventional radiography with ultrasound for the diagnosis of pneumonia

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Introduction: Pneumonia is a serious and common infectious disease with high morbidity and mortality. Recently, the use of lung ultrasound as a standard device in emergency centers has begun, which is a fast and accessible way of diagnosing pneumonia. The aim of the present study was to comparison the diagnostic accuracy of conventional radiography with ultrasound for the diagnosis of pneumonia.

Materials and Methods: This study was performed on 146 patients over 18 years old who referred to the emergency department of Kowsar Hospital in Sanandaj in 2017-2018. Portable ultrasound and radiography were performed for all patients. Ultrasound images were recorded by a sonologist with the presence of an emergency medicine specialist and an emergency medicine resident. In these patients, CT scans were used as a gold standard to compare the results of chest radiographs and portable ultrasound. Sensitivity, specificity, positive and negative predictive value of ultrasound to radiography in the diagnosis of pneumonia were calculated.

Results: In this study 146 patients with the mean age of 64.2 years old were studied. 65% of patients had febrile, 63% of patients had sputum, 58.9% had pathologic auscultation, 52.7% had cough and 52.1% had shortness of breath. Results showed that sensitivity, specificity, positive predictive value and negative predictive value of ultrasound test were 44.4%, 100%, 100% and 0%, respectively, and for radiographic test were 25.92%, 100%, 100% and 0%, respectively. The results also showed that sensitivity, specificity, positive predictive value and negative predictive value, and area under the ROC curve of sonography test compared to the radiographic test were 91.27%, 0%, 95.83%, 0% and 91.3%, respectively.

Conclusion: The findings of the present study showed that ultrasound is very accurate in the diagnosis of pneumonia and because of its availability and feasibility; it can be a good alternative for chest radiography and chest CT scan.

Keywords: Diagnostic value, Ultrasound, Radiography, Pneumonia, Emergency

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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Introduction

Pneumonia is a common and serious infectious disease that is sometimes treated with misdiagnosis. Proper and timely antibiotic treatment is crucial^[1]. Pneumonia, is an acute infection of the lung parenchyma associated with acute symptoms of infection that is confirmed by acute infiltration in the chest X-ray or by detecting changes in sound in physical examination of the patient and the diagnosis is made in a patient who is not hospitalized or at least has not been hospitalized for the past 14 days^[2,3]. Symptoms of the disease include cough, sputum cough, dyspnea, fever and pleuritic pain. Community Acquired Pneumonia (CAP) is particularly important in the elderly because of its high prevalence, mortality, and significant complications^[4]. The prevalence of this pneumonia has been reported in about 12 cases per 1000 people and is the most prevalent in both ends of the age spectrum (1). According to WHO statistics in the year of 2000, about 4 million deaths worldwide were caused by acute respiratory infections which about 90% of them were caused by acute pneumonia and 1.9 million were in children under the age of 5^[5]. Most of these statistics are related to developing countries due to underlying malnutrition^[6]. On the other hand, acute respiratory infection, especially pneumonia, accounts for about 20% of all child deaths, so that for every 1,000 live births in

developing countries, 12 to 20 children are die due to pneumonia before the age of 5^[7].

Improvement of abnormal radiographic findings usually delay compared to the patient's clinical findings by several weeks to months, so that usually Healing to normal lung in 4 to 6 weeks later. However, abnormal chest X-ray after three months of pneumonia in a child will require further investigation, so delayed chest X-ray is not recommended for routine follow-up of children with acute pneumonia^[8,9].

Chest radiography is currently the most common imaging technique used to diagnosis of pneumonia. Although radiography can be performed on a patient's bed without displacement, only brief information can be obtained in one or two images. Therefore, it sometimes leads to misdiagnosed^[10-12].

However, Chest x-ray is the most common method for the diagnosis of pneumonia this method has relatively low sensitivity and specificity and is not possible to use in pregnancy or is associated with risk^[13,14]. On the other hand, in patients admitted to intensive care units or in hospitalized patients who are unable to upright standing, the use of sleeping x-ray does not provide valuable information because of poor quality. The definitive method of diagnosis as the gold standard is the use of CT scan^[3,5]. Also, disapproval of pneumonia in the x-ray increases antibiotic use and its complications. One of the graphical problems in neonates is the non-differentiation of lung tissue from other tissues due to the thymus shadow and the components of the thoracic cavity, which may cause no diagnosis of remission or loss of middle lobe pneumonia. Today the alternative available method, according to studies, is chest ultrasound^[15].

According to the importance of accurate and rapid diagnosis of pneumonia in patients and the inability of CT scan and CXR in all patients as well as in cases of unstable patients, ultrasound can be a very desirable method in this regard. In addition, ultrasound is low cost compared to CT scans and CXR and is without radiation and complications and can be performed in remote areas and in war zones as well as in natural disasters^[16]. Given the aforementioned, in order to replace less aggressive modalities and not to impose interventions with complications on patients and also to perform bed side modalities, our aim in this study was to compare the diagnostic accuracy of conventional radiography and ultrasound for the diagnosis of pneumonia. If there are acceptable results, ultrasound can replace radiography.

Materials and Methods

The present study is a study of determination of diagnostic value performed on 146 patients over 18 years old who referred to the emergency department of Kowsar Hospital of Sanandaj in 2017-2018. Portable ultrasound and radiography were performed for all patients. Ultrasound images were recorded by a sonologist with the presence of an emergency medicine specialist and an emergency medicine resident.

All patients presenting with clinical suspicion of pneumonia and having inclusion criteria including fever, tachypnea, respiratory distress, cough and decrease of O₂ saturation were subjected to chest ultrasound by an emergency medicine resident prior to radiography and were evaluated for diagnostic criteria of pneumonia. The used ultrasonography system was 2004 Japanese ultrasonography system Siemens model gm-6703a-2600.

Along with sonography, the patient's history and clinical examination (cough, sputum, fever, pathologic findings in auscultation) were also evaluated. For ultrasound, the thorax was divided into anterior (parasternal line to anterior axillary line), lateral (between anterior and posterior axillary line) and posterior (from posterior axillary line to paravertebral line). Ultrasound was performed in the intercostal space parallel with each rib with the convex probe. The position of the patients for ultrasound, for the anterior part was supine, for lateral part was lateral decubitus and for the posterior part was prone. Findings in pneumonia were including hypo-echo area with different size and shape, air bronogram, fluid bronchogram, B-lines (comet-tail artifacts), intraconsolidar vascular design, and pleural effusion. The presence of each of these findings confirmed the pneumonia in the symptomatic individuals.

In these patients, CT scans were used as a gold standard to compare the results of chest X-rays and ultrasound findings. Statistical indices such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) were calculated and area under the ROC curve was reported. Each of the indices was recalculated to compare the results of the ultrasound and radiography with the CT scan (Gold Standard). Data were analyzed using SPSS 20 software.

Results

In this study, 146 patients with the mean age of 64.2 years were studied, of whom 76 cases (52.1%) were female. From the clinical point of view, 65% of the patients had fever, 63% had sputum, 58.9% had pathologic auscultation, 52.7% had cough and 52.1% had dyspnea (Table 1). Results showed that sensitivity, specificity, positive predictive value and negative predictive value of ultrasound test were 44.4%, 100%, 100% and 0%, respectively (Table 2) and radiographic test were 25.92%, 100%, 100% and 0%, respectively (Table 3). The results also showed that sensitivity, specificity, positive predictive value and negative predictive value, and area under the curve of ultrasound ROC test were 91.27%, 0%, 95.83%, 0% and 91.3% respectively (Table 4).

Discussion

In this study 146 patients with mean age of 64.20 years were studied. From the clinical point of view, 65% of patients had fever, 63% had sputum, 58.9% had pathologic auscultation, 52.7% had cough and 52.1% had dyspnea. In the study of Mohammadi Fard and Ebrahizadeh^[17] the most common symptoms were fever (96%), cough (89.5%), sputum (84%) and abnormal auscultation in clinical examination including diminished or completely absent sounds, fine and coarse crackle and wheezing had heard in 88% of cases. In the study of Diehr et al., The most common symptoms of pneumonia were cough (92%), fever (91%), sputum (78%) and pleuritic pain (41%)^[18]. In the studies performed in the United States, Spain and Brazil, fever was the most common symptom of pneumonia at the time of admission^[19,20]. The results of this study were in agreement with the results of other studies, so that fever was the most common symptom of patients with infection and accounting for more than 60%.

Results showed that sensitivity, specificity, positive predictive value and negative predictive value of ultrasound test were 44.4%, 100%, 100% and 0%, respectively, and for radiographic test were 25.92%, 100%, 100% and 0%, respectively. The results also showed that sensitivity, specificity, positive predictive value and negative

Table 1: Frequency of the demographic variables and signs and symptoms suspicious to pneumonia in the studied patients

Variables	Frequency	Percentage
Gender	Male	70 47.9
	Female	76 52.1
Respiratory Distress	Yes	2 1.4
	No	143 99.3
Tachypnea	Yes	3 2.1
	No	142 99.3
Fever	Yes	50 34.2
	No	95 65.1
Dyspnea	Yes	69 47.3
	No	76 52.1
Cough	Yes	77 52.7
	No	68 46.6
Sputum	Yes	53 36.3
	No	92 63
Low Saturation	Yes	1 0.7
	No	144 98.6
Pathologic Auscultation	Yes	60 14.1
	No	86 58.9

Table 2: Frequency of findings of CT scan and ultrasound in the diagnosis of pneumonia

Diagnostic method	CT scan	ultrasound	Positive percentage	Negative percentage	Total
Positive			12	0	12
Negative			15	0	15
Sensitivity				44.4	
Specificity				100	
Positive Predictive Value				100	
Negative Predictive Value				0	

Table 3: Frequency of findings of CT scan and radiography in the diagnosis of pneumonia

Diagnostic method	CT scan	radiography	Positive percentage	Negative percentage	Total
Positive			7	0	7
Negative			20	0	20
Sensitivity				25.9	
Specificity				100	
Positive Predictive Value				100	
Negative Predictive Value				0	

Table 4: Frequency of findings of ultrasound and radiography in the diagnosis of pneumonia

Diagnostic method	ultrasound	radiography	Positive percentage	Negative percentage	Total
Positive			115	0	122
Negative			11	0	11
Sensitivity				91.2	
Specificity				0	
Positive Predictive Value				95.8	
Negative Predictive Value				0	

predictive value, and area under the curve for sonography test were 91.27%, 0%, 95.83%, 0% and 91.3%, respectively. In the study of Amatya et al., sensitivity of Sonography was significantly higher than radiography, but specificity of sonography and radiography were similar and were 61% and 50%, respectively. The positive predictive value of sonography and radiography were 85% and 78%, respectively, and the negative predictive value of these two tests was 73% and 43%, respectively. Positive and negative likelihood ratio of sonography were 2.34 and 0.15, respectively, and 1.45 and 0.55 in

radiography, respectively^[21,22]. In a meta-analysis study by Long et al., the overall sensitivity of ultrasound was 88% and its specificity was 86%, and the accuracy of ultrasound testing using the ROC curve level was reported to be 0.95^[23]. In the study of Ye et al., 95% overall sensitivity and 91% specificity were reported^[14]. In the study of Liu et al., sensitivity of sonography was 94% and for radiography was 78%. They also showed that ultrasound sensitivity was higher (99% vs. 61%) when the gold standard test is CT scan^[24]. In addition, in the study of Chavez et al., the positive likelihood ratio, negative

likelihood ratio and ultrasound AUC were 16.8 (95% CI: 7.7-37), 0.07 (95% CI: 0.05-0.10) and 0.98 (95% CI: 0.98 - 0.99), respectively^[25]. Pereda et al. Showed sensitivity, specificity, and positive and negative likelihood ratio of ultrasound were 96% (95% CI: 94-97%), 93% (95% CI: 90-96%) and 15.3 (95% CI: 6.6-35.3) and 0.06 (95% CI: 0.03-0.11), respectively^[26]. Based on the results of many studies, ultrasound was more sensitive compared to radiography in the diagnosis of pneumonia^[27-31].

Conclusion

The findings of the present study showed that ultrasound is very accurate in the diagnosis of pneumonia and because of the availability and feasibility of this test can be a good alternative for chest radiography and chest CT scan.

Conflict of Interest

The authors declare that they have no conflict of interest.

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