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Value of Chest Ultrasound in Management of Patients with Acute Decompensated Heart Failure

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Abstract

Objective: To evaluate the performance of lung ultrasound (LUS) in diagnosis of pulmonary congestion in patients with acute decompensated heart failure (ADHF). Missed or delayed diagnosis of patients with ADHF is associated with poor outcome. Lung Ultrasound has been demonstrated to be a valid tool for the assessment of pulmonary congestion through the quantification of the B-lines. The use of LUS to properly diagnose pulmonary congestion may provide early recognition of acute heart failure and the consequent early appropriate treatment. Methods: A total of 200 eligible patients with a diagnosis of ADHF who met the inclusion criteria were enrolled. They were diagnosed based on clinical (i.e. oxygen saturation (SO2)) and radiological (i.e. chest x-ray score) congestion parameters. Lung ultrasound was done on admission, after 24h and after 48h post admission. Lung ultrasound score was then correlated with other variables of congestion. Results: Lung ultrasound score showed correlations with other variables of congestion during the first 48h of admission. Conclusion: Lung US is a reliable tool for diagnosis of pulmonary congestion. The integration of lung US with the current diagnostic methods may have the potential to accelerate and improve the accuracy of ADHF diagnosis.

Keywords: Acute decompensated heart failure, pulmonary congestion, lung ultrasound, B-lines, diagnosis of pulmonary congestion.

1. Introduction

Acute HF is a leading cause of hospitalizations in subjects aged >65 years and is associated with high mortality and rehospitalization rates. In-hospital mortality ranges from 4% to 10%. [1] Post-discharge 1-year mortality can be 25-30%. [2]

Patients with AHF require urgent evaluation with subsequent initiation or intensification of treatment, including i.v. therapies or procedures. [3]

The initial diagnostic work-up of ADHF has remained fundamentally unchanged over the past decades and may be heavily undermined by several factors, such as the poor sensitivity of the physical examination, electrocardiogram inaccuracy, and unreliability of chest radiography findings [4]

Missed or delayed diagnosis of acute decompensated heart failure (ADHF) is associated with prolonged hospital stay, higher rates of ICU admission, higher mortality, and increased costs [5].

Lung Ultrasound (LUS) has been demonstrated to be a valid tool for the assessment of pulmonary congestion through the quantification of the B-lines. [6]

2. Patients and methods

2.1. Study population

This study is a single center, prospective and randomized aiming at assessment of value of chest ultrasound in management of patients with ADHF.

The study recruits adult patients admitted with ADHF and EF < 40% to the Cardiology Department of Benha University Hospital, during the period from September 2020 to February 2021.

Inclusion criteria were adult patients >18 years with decompensated heart failure with reduced ejection fraction (EF <40%), met diagnostic criteria for ADHF (NYHA CLASS III, IV). We have excluded Patients that had renal impairment, end-stage renal disease or the need for renal replacement therapy, diuretics resistance, multi-organ failure, shock state, the need for fluid resuscitation, heart failure with preserved (HFpEF), mid-range (HFmrEF), pneumonia, ARDS and interstitial lung disease.

For each patient, a detailed medical history, complete physical examination, CCU monitoring, Killip classification, laboratory analysis, standard

12-lead electrocardiogram, chest radiograph, conventional echocardiographic examination and chest ultrasound examination.

2.2. Chest radiograph

For confirming the diagnosis of pulmonary edema and exclude other pulmonary causes of dyspnea. It was also used for Assessment of degree of pulmonary congestion through a previously validated radiologic score (RS; range, 0-18).

2.3. Echocardiography

All patients were submitted to detailed echocardiography within 24 hours of admission using Philips Epic 7 with multi-frequency transducer.

Echocardiographic examination including M-mode and two-dimensional (2D) to measure EF, detect LV dimensions, wall thickness, RWMA and valvular

affection if present. Left ventricular ejection fraction was measured also using a biplane modified Simpson's method.

2.4. Chest ultrasound

The anterior chest wall was delineated from the sternum to the anterior axillary line and was subdivided into upper and lower halves, from the clavicle to the diaphragm. The lateral zone was delineated from the anterior to the posterior axillary line and was subdivided into upper and lower halves (the area above the fourth intercostal space was defined as the upper area).**[7]** We adopted an 8-zone protocol. The elementary findings that

were evaluated were the ULCs (also known as B-lines), defined as hyper echogenic, vertical comet tail artifacts with a narrow base, spreading from the pleural line to the further border of the screen.[8]

All Data was recorded on admission, after 24 hours and after 48 hours from admission. Chest ultrasound score changes were correlated with changes in clinical and radiological variables of pulmonary congestion.

3. Results

All the included patients had a median age 63 (IQR 49-71) years old. Males were 62% versus 38% of females, 152 patients (76%) were diabetic, 132 (66%) were hypertensive. Regarding etiology of heart failure, ischemic heart disease was the most prevalent chronic

illness among the included patients (78%), rheumatic

heart disease in 8% and idiopathic in 14% of cases.

Correlations between chest ultrasound score and variables of congestion (i.e. clinical and radiological) were done.

Among the included patients, chest US on admission was negatively correlated with oxygen saturation on admission with p value 0.0001 and r=-0.45. Chest US was positively correlated with CXR score with p value 0.0001 and r=0.35.

Chest US after 24h of admission was positively correlated with CXR score with r=0.19 and p value 0.007. Chest US after 24h of admission was negatively correlated with oxygen saturation with p value 0.03, and r=-0.146.

Chest US score after 48 hours of admission was negatively correlated with oxygen saturation with p value 0.0001 and r= -0.27. Chest US score was positively correlated with CXR score with p value 0.0001 and r= 0.23.

Table (1) Demographics and comorbidities among the included patients.

		Median/ count	IQR/ %
Age		63	49 - 71
Gender	**Male**	124	62.0%
	Female	76	38.0%
Comorbidities	**Diabetes mellitus**	152	76%
	Hypertension	132	66%

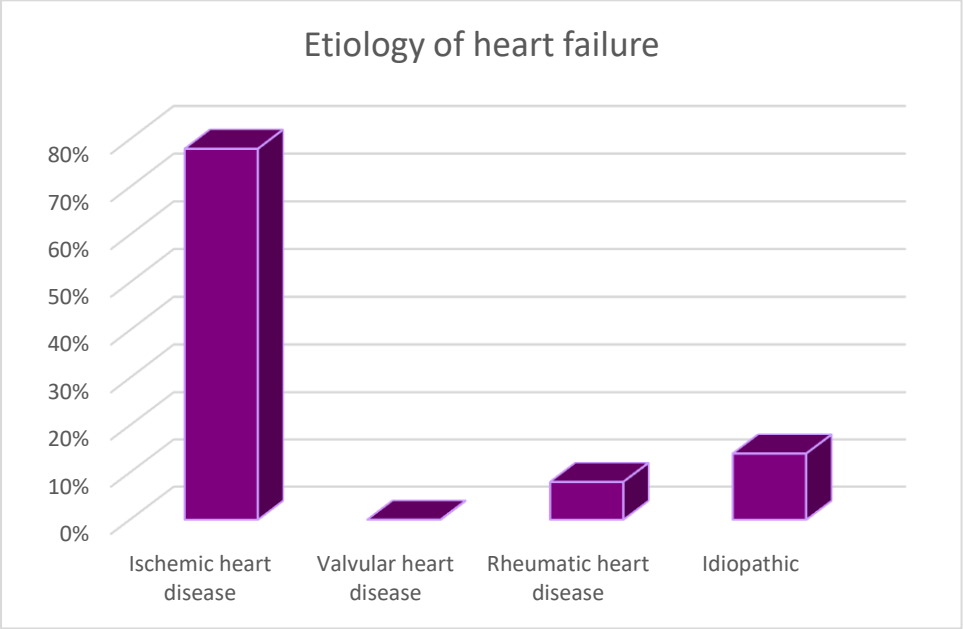

Fig. (1) bar chart showing underlying etiology of heart failure.

4. Discussion

Regarding role of LUS in diagnosis of pulmonary congestion in patients with ADHF, LUS score showed moderate correlations with clinical and radiological variables during admission period in this study. Lung US score was correlated with clinical and radiological variables of congestion i.e., oxygen saturation and CXR score in different times during admission. This was similar to **Volpicelli et al., 2008**. The US score showed positive linear correlation with radiologic score (r = 0.62; P < .05), clinical score (r = 0.87; P < .01), and brain natriuretic peptide levels (r = 0.44; P <.05). Δ Sonographic score correlated with Δ

clinical (r = 0.55; P < .05) and radiologic (r = 0.28; P < .05) scores.**[9]** As **Zanobetti et al., 2017** who found that US and the ED diagnoses showed good concordance and point of care US was significantly more sensitive for the diagnosis of HF than a standard ED evaluation.**[10]** Also **Sartini et al., 2017** found that combining the chest X-ray and lung ultrasound was the best overall performance with 84.69 % sensitivity, 77.69 % specificity and 87.07 % negative predictive value.**[11]** It was also the recommendations of **Pivetta et al., 2019**. They found that the diagnostic accuracy of the LUS-integrated approach was higher than that of the CXR/Nt-proBNP-integrated approach (p<0.01). **[12]** However, there was disagreement form **Balen et al., 2021**. They concluded that there was no statistically significant difference between point of care US and a combination of clinical, radiographic, and biological findings for the diagnosis of ADHF.**[13]**

5. Conclusion

Lung US is a reliable tool for diagnosis of pulmonary congestion and improve the accuracy of ADHF diagnosis.

6. Limitations

This was a single-center investigation of a small patient population. Also LUS is an operator dependent modality.

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