Point of Care Lung Diagnostic in ICU – Our Experience with Bedside Lung Ultrasound

Filip Naumovski[1,2(✉)] and Biljana Kuzmanovska[1,2]

[1] Department of Anesthesia, Reanimation and Intensive Care, University "St. Cyril and Methodius", Skopje, North Macedonia
[2] Department of Anesthesia, Reanimation and Intensive Care, University Clinical Center Mother Theresa, Skopje, North Macedonia

Abstract. Lung ultrasound as a Point of Care (POC) diagnostic technique might be a helpful tool in clinical decision making in critically ill patients. The aim of this study is to present 6 months experience of using lung ultrasound as a point of care tool in ICU. We performed a retrospective study of clinical records in patients with respiratory failure hospitalized in the ICU. The examination was made according to the BLUE Protocol (1). LUS was used in 48 out of 180 patients (26.6%). Pathological findings were noted in 42 patients (87,5%). Pleural effusion was detected in 10 patients (23.8%). Signs of interstital syndrome were detected in 21 patients (50%). Two patients (4.7%) had pneumothorax. Lung consolidation was detected in 18 patients (42.8%); 8 patients (44.5%) with pneumonia and 10 patients (55,5%) with atelectasis. According to the results of the LUS in 19 patients (45.3%) some sort of invasive procedure was undertaken. In 7 patients (36,8%) thoracic drainage was performed and bronchoaspiration in 4 patients (21%). In 12 patients (63.1%), mechanical ventilation was initiated. POCLUS is a helpful tool for rapid assessment of underlying pathological substrate in critically ill patients with acute respiratory failure having important role in clinical decision making.

Keywords: Point of care · Lung ultrasound · Critically ill

1 Introduction

Acute respiratory failure is one of the most frequent causes for admission of critically ill patients in the Intensive Care Unite (ICU). No matter etiology, due to critical illness, acute respiratory failure (ARF) could be developed lately in the ICU, also. According to the dynamic nature of critical illness, rapid and bedside assessment of the failing lungs in a critically ill patient is more than essential. It is well known that the goal of Point of Care methods usage is providing immediate diagnosis and fast treatment decision when it is used near to the site of patient wherever medical care is needed, especially in critical illness and emergencies [1]. Therefore, we considered that Point of Care (POC) Lung Ultrasound (LUS) might be a helpful tool while providing immediate diagnosis and care in patients with acute respiratory failure.

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2 Aim of Study

The aim of this study is to present our 6 months experience of using LUS as a point of care diagnostic tool in a tertiary University Clinic ICU while treating critically ill patients who exhibit signs and symptoms of acute respiratory failure.

3 Material and Methods

We performed a retrospective study of the clinical records of patients experiencing respiratory failure hospitalized in the ICU of Clinical Center "Mother Teresa" in Skopje, North Macedonia for the period from January 1st 2020, till June 30th 2020. We have defined ARF as a clinical condition in patients with SpO_2 lower than 90%; patients having PaO_2 lower than 60 mmHg and/or with $PaCO_2$ higher than 45 mmHg as well as those patients with PaO_2/FiO_2 ratio lower than 300. All patients included in the study were examined according to the BLUE Protocol [2]. While using the well-known BLUE Protocol for LUS assessment, 12 separated lung areas, 6 in the left and another 6 segments in the right lung should be examined. Each of the examined areas right upper anterior and right upper posterior, right lower anterior and right lower posterior, left upper anterior and left upper posterior as well as left lower anterior and left lower posterior segments should be examined due to LUS assessment in a timeframe no longer than 3 min as described within BLUE Protocol. Our primary goal was to detect any presence of pathological finding in the lungs making distinction from the patients with normal findings, described in the literature as a presence of A-lines and intact pleural sliding in all areas examined. Under the term "pathological findings", we considered disappearing A-lines and abolished lung-sliding, appearance of a more than 3 B-lines, detecting lung consolidations with static or dynamic bronchograms and detecting pleural effusions. We have examined 48 critically ill patients exhibiting signs and symptoms of ARF. Patients were examined in semirecumbent position or in a supine position if they were already intubated. Because our hospital was not designated as a regional COVID Center, in this study we did not include patients experiencing COVID Pneumonia. LUS exam was made with Ultrasound Machine Mindray TP2200 using the curvilinear probe.

4 Results

In our study we have used LUS assessment for ARF in 48 out of 180 critically ill patients (26.6%) where 27 (56,25%) were male and 21 (45,75%) were female. According to the results, pathological findings were detected in 42 patients (87,5%), while the other 6 patients (12,5%) have had normal findings. Pleural effusion was detected in 10 patients (23.8%). More than 3 B-lines in a examined rib interspace with present pleural sliding as a sign of interstitial syndrome were detected in 21 patients (50%). Presence of A-lines but absent pleural sliding suggesting pneumothorax was detected in 2 patients (4.7%). In 18 patients (42.8%) presence of tissue like structure suggesting lung consolidation was found; where in 8 patients (44.5%) the consolidation was accompanied with presence of dynamic bronchograms suggesting pneumonia and in 10 patients (55,5%) atelectasis was found where consolidations were accompanied with static bronchograms. In 9 out

of 42 patients (21,4%) we have detected overlapping of two or more findings at the time of examination. According to the results of the LUS in 19 patients (45.3%) some sort of invasive procedure was undertaken. In 7 patients (36,8%) thoracic drainage was established. Bronchoaspiration was indicated in 4 patients (21%). In 12 patients (63.1%), mechanical ventilation was initiated (Tables 1 and 2).

Table 1. Total number of examined patients and patients with normal and pathological findings

Patients examined with LUS	Number of patients
Total number of examined patients	48 (100%)
Normal LUS findings	6 (12,5%)
Pathological findings	42 (87,5%)

Table 2. Types of pathological findings detected by LUS

Findings	Description of LUS result	Patients
Pathological findings	Interstital syndrome (Presence of ≥3 B-lines in one or more intercostal spaces)	21 (50%)
Pathological findings	Pneumothorax (Presence of A-lines, but abolished or absent pleural slidinw with "Barcode" sign in M-mode)	2 (4.7%)
Pathological findings	Pleural effusions (anechoic areas)	10 (23,8%)
Pathological findings	Consolidation with bronchogram	18 (42,8%)

5 Discussion

Critically ill patients experiencing signs and symptoms of acute respiratory failure demand emergent and bedside diagnosis of the cause why lungs are failing. According to the review of literature made by Gentle S. et al. usage of LUS in diagnosis of the most frequent causes of ARF as Pneumonia, Pulmonary edema, Pleural effusions and Pneumothorax is superior when compared to chest radiograph and is comparable to the usage of chest CT [3] also is faster, easy to use, repeatable and without radiation exposure [4]. We have used LUS as a tool supposed to help in diagnosing the cause or underlying condition that leads to respiratory failure in our patients in a six months period. Practicing bedside LUS has given us the answer why lungs are failing in 87.5% of the examined patients. Lichtenstein D and Meziere G. have reported similar results where LUS has provided immediate diagnosis of acute respiratory failure in 90.5% of critically ill patients [2].

Pleural effusion was detected in 23.8% of patients while half of them had small bilateral effusions and the other half were unilateral needing thoracic drainage. Pleural effusions were observed as dark anechoic areas in the dependent regions surrounding the

lungs and eventually compressing the lung that in some cases leaded to aeration impairment. Diagnostic accuracy of bedside lung ultrasound for detecting pleural effusions is 93% [5–7] (Fig. 1).

Fig. 1. Pleural effusion surrounding and compressing already atelectatic lung

More than 3 B-lines arousing from the pleural line, hyperechoic by their nature, well defined, laser like and moving left and right during breathing with intact plural sliding were observed in 50% of the patients implying presence of pulmonary edema. This finding in the literature is described as interstitial syndrome which could be detected by the bedside LUS with the accuracy of 93–95% [2, 6]. Detecting of more than 3 B-lines implies erasing the normal A-lines as the result of the accumulation of extravascular lung water no matter primary cause of the edema (Fig. 2).

Lung sliding where visceral and parietal pleura slide one against another with detectable A-lines under the pleural line are normal findings. Abolished or absent pleural sliding in the anterior parts of the examined areas when the patient is in a supine position with present A-lines is typical for pneumothorax [2, 8, 9] which was found in 2 patients (4.7%). Presence of a "Barcode sign" in M-mode Lung ultrasonography has a confirmatory value when diagnosing pneumothorax [3]. Diagnosing pneumothorax with LUS is superior to supine chest radiography where ultrasound sensitivity is 92–100% and the specificity is 91–100% [10].

We observed tissue like structure of the lung or/and the "shred sign" in 18 (42,5%) of the patients with pathological findings, suggesting presence of lung consolidation. All consolidations were observed in the lower anterior and posterior segments and in 5 patients were accompanied with surrounding pleural effusion. When tissue like structure of the lung is present it can be compared with the structure of the liver/spleen and it is called translobar consolidation [3, 5] but more frequently smaller lung consolidations are observed as subpleural areas with irregular border from the surrounding normal lung tissue named as "shred sign" [3, 11]. In 44.5% of the patients with consolidation, we detected presence of dynamic bronchograms that are pathological findings typical

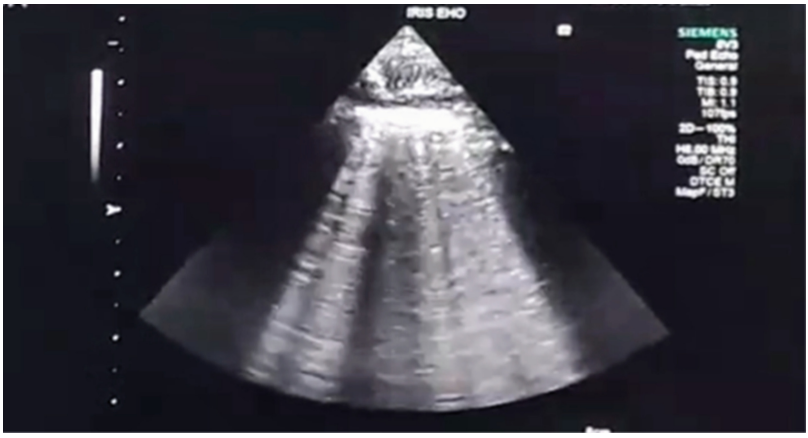

Fig. 2. Thickened pleural line and multiple well defined, hyperechoic B-lines suggesting interstitial syndrome

for pneumonia. Dynamic bronchograms are pathological findings of air-filled bronchi moving for more than 1mm during inspiration and have a sensitivity of 94% when differentiating pneumonia from atelectasis [12]. Static bronchograms were found in 55,5% of the patients with pathological findings suggesting atelectasis. LUS has 97% accuracy when it comes to diagnosing of alveolar consolidation [6] (Fig. 3).

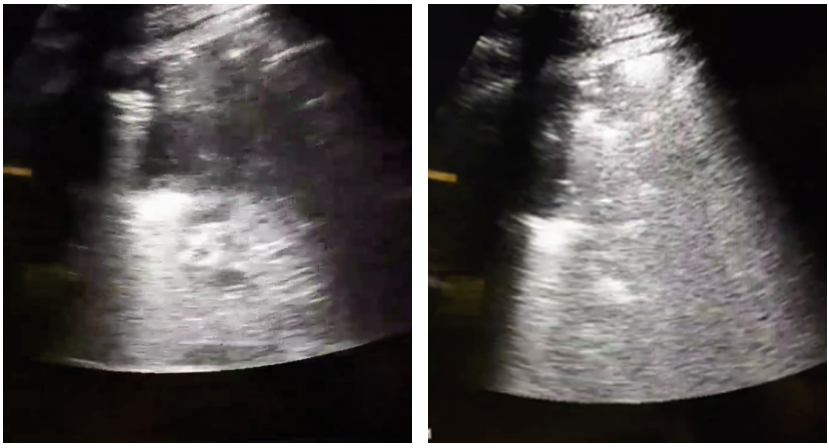

Fig. 3. Lung consolidation with presence of hyperechoic bronchogram

6 Conclusions

Based on the results from the study we can conclude that Point of Care LUS is a helpful tool for rapid assessment of underlying pathological substrate in critically ill patients with acute respiratory failure and have important role in clinical decision making.

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