

POINT OF CARE LUNG ULTRASOUND IN MECHANICALLY VENTILATED PATIENTS

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ABSTRACT

Objective: To assess the role of lung ultrasound in mechanically ventilated patients in intensive care setting in this part of the world.

Study Design: Prospective observational study.

Place and Duration of Study: Pak Emirates Military Hospital Rawalpindi Pakistan, Feb 2015 to Jul 2015.

Methodology: We studied 76 patients who fulfilled the criteria of being mechanically ventilated and had computed tomography scan chest. Point of care lung ultrasound was performed in all patients within 6 hours of computed tomography chest and findings were compared with computed tomography scan.

Results: Of 76 patients 50 were male and rest 26 were female. The mean age of subjects was 42.3 ± 7.8 years ranging from 14 to 73 years. Lung sonography demonstrated hundred percent diagnostic accuracy for pneumothorax and pleural effusion whereas it was 91% and 75% for interstitial syndrome and consolidation respectively.

Conclusion: Thoracic ultrasound was found a safe and reliable diagnostic tool for mechanically ventilated critically ill patients and results are nearly equivalent to Computed Tomography scan.

Keywords: Consolidation, Interstitial syndrome, Lung ultrasound, Pneumothorax, Pleural effusion.

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INTRODUCTION

Point of care lung ultrasound (LU) has gained popularity in acute and critical care units with significant positive impact but still computed tomography (CT) scans and x rays are being used more frequently and reliably than ultrasound in this part of the world. Lung sonography is a safe and noninvasive tool which can be performed conveniently during emergency situations without exposing patient to radiation and potentially life threatening risk during transfer of mechanically ventilated patients to radiology department for CT scans¹. LU relies on the interpretation of artifacts which will vary depending on the ratio of air and fluid. It has an important role in the diagnosis of following pathological entities:

Pneumothorax: The features of a pneumothorax are absence of lung sliding, lung pulse, B lines and presence of lung point².

Interstitial Syndrome: Three or more B lines between rib spaces are the sonographic sign of lung interstitial syndrome. These are vertical lines extending from pleural surface to maximum depth of image, move with lung sliding and obliterate A lines. It is caused by pulmonary oedema, interstitial pneumonia and lung fibrosis³.

Consolidation: Lung consolidation can be diagnosed on ultrasound by linear or pinpoint hyperechoic opacities (hepatization)^{4,5}.

Pleural Effusion: LU can reliably identify pleural effusion as an anechoic or hypoechoic between the diaphragm and lung posterolaterally and reveal septations to distinguish between transudate and exudate³.

The objective of this study was to determine the value of Lung ultrasound in mechanically ventilated patients in intensive care setting in our part of world.

METHODOLOGY

This prospective observational study was conducted in medical intensive care unit of Pak

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Emirates Military Hospital Rawalpindi Pakistan from February to July 2015. We studied 76 patients who fulfilled the criteria of being mechanically ventilated and had CT scan chest. By using non probability consecutive sampling technique, 48 cases were selected.

Informed written consent was obtained from next of kin of enrolled patients.

Point of care lung ultrasound was performed in all patients within 6 hours of CT chest. For data analysis each hemithorax was divided into six regions delineated by the anterior and posterior axillary lines, three in upper field (anterior, posterior, lateral) and three in lower field (anterior, posterior, lateral).

Ventilator settings were not altered for the study.

Four entities were evaluated by both ultrasound and CT scan: (1) Pneumothorax (2) Interstitial syndrome (3) Consolidation (4) Pleural effusion.

The findings of ultrasound were compared with corresponding CT scan results. Sensitivity,

mean of 23.6 in enrolled subjects. Intensivist spent seven minutes on average on each ultrasound examination. Ultrasound findings were compared with CT scan findings (table-II).

Abolished lung sliding, absence of B lines, lung pulse and presence of the lung point were found in all five CT confirmed pneumothoraces patients. There was no false positive or negative

Table-I: Patient characteristics and time spent on each ultrasound examination.

Parameter	Characteristics
Age (years)	14 to 73 (42.3 ± 7.8)
Gender (Male/Female)	50/26
Body mass index	19 to 33 (23.6 ± 3.5)
Time consumed on each ultrasound (minutes)	6 to 12 (7.1 ± 2.5)

result.

Forty six enrolled subjects had B profile on lung ultrasound as compared to forty nine individuals on chest CT scan. Lung sonography missed five CT confirmed cases of interstitial

Table-II: Comparison of Lung sonography with Computed tomography chest findings.

Pathology	Lung Ultrasonography	CT+ (n)	CT- (n)	Sensitivity (%)	Specificity (%)	Diagnostic Accuracy (%)
Pneumothorax	Lung Ultrasonography Positive	5	-	100	100	100
	Lung Ultrasonography Negative	-	71			
Interstitial syndrome	Lung Ultrasonography Positive	44	2	90	93	91
	Lung Ultrasonography Negative	5	25			
Consolidation	Lung Ultrasonography Positive	32	8	74	76	75
	Lung Ultrasonography Negative	11	25			
Pleural effusion	Lung Ultrasonography Positive	48	-	100	100	100
	Lung Ultrasonography Negative	-	28			

specificity and diagnostic accuracy for each disease was calculated by using standard formulas.

RESULTS

The patient characteristics and time consumed on each thoracic sonographic assessment are mentioned in table-I. Of 76 patients 50 were male and rest 26 were female. The mean age of subjects was 42.3 years ranging from 14 to 73 years. Body mass index was recorded from 19 to 33 with the

syndrome and revealed two falsely positive results.

Lung ultrasound was suggestive of consolidation in 40 out of 76 studied subjects whereas it was confirmed in 43 on CT chest. Eight subjects were falsely positive while eleven CT confirmed consolidation were missed by sonographic assessment.

Lung sonography accurately picked up all 48 cases of CT confirmed pleural effusion.

DISCUSSION

This study demonstrated the significance of ultrasound examination in critical care settings in this part of the world and results were almost comparable with CT scan chest.

Pneumothorax was diagnosed in nearly seven percent of subjects in our study as compared to one⁶ and ten percents⁷. This disparity could be due to different sample size ranging from 11506 to 307 as compared to our 76 sonographic examination of lung. Pneumothorax was diagnosed with ultrasound accurately in 100 percent of cases in this study. This outcome is in line with the study conducted by Rizk *et al* in 2016⁷. They did not miss any clinically significant pneumothorax and found pneumothorax in 3 out of 30 patients which were confirmed on CT (two cases) and chest xray (one case). No false positive result was obtained. Xirouchaki *et al*⁸ reported five falsely positive pneumothoraces patient on ultrasound examination in a mixed medical-surgical ICU in contrast to our study which was conducted in an exclusively medical ICU. All five were considered to be small in size and not affecting the overall clinical picture of patient. Out of five, three were seen in patients with subcutaneous emphysema due to chest trauma while two were noted in patients with severe chronic obstructive pulmonary disease and over inflation. Lung sonography also missed couple of small pneumothoraces in the apical region in this study but none required any intervention.

Lung ultrasound is an attractive tool to assess pulmonary fluid status in intensive care setting. Our study accurately diagnosed interstitial syndrome in 91 percent of subjects which was slightly less as compared to results reported by Xirouchaki *et al*⁸ and Lichtenstein *et al*⁹ respectively. This minor difference could be incidental or due to some variation in sampling. Current study missed five CT confirmed cases of interstitial syndrome on lung ultrasound which could be due to the treatment given during the time elapsed between two examinations as ultrasound was carried out after the CT scan and this interval

is adequate for resolution of B lines. We revealed two falsely positive results in patients with lung fibrosis¹⁰.

The sensitivity and specificity of lung sonography for the detection of consolidation in our data was 74% and 76% which is much lower than the current available data ranging from 88 to 95%^{5,11-13} and 86 to 99 percent^{5,12,13} respectively. LU missed eleven cases of pneumonia which were confined to lung parenchyma only and did not involve pleura. This limitation of lung sonography in diagnosis of consolidation was also observed in previous studies conducted by Amatya *et al*¹¹ and Reissig *et al*¹⁴. CT scan revealed bronchiectasis in all eight falsely positive reported pneumonia cases on ultrasound. Bronchiectasis was reported in few cases as one of the cause of falsely positive lung ultrasound in the available data as well¹¹. The higher number in our study may be due to increased prevalence of tuberculous bronechiectasis in this part of the world. Therefore intensivists should be careful in reporting consolidation on ultrasound in bronchiectatic patients¹⁵⁻¹⁸.

Ultrasound successfully diagnosed presence of fluid in pleural cavity in all CT confirmed pleural effusion cases. This data is in line with Xirouchaki *et al* study⁸.

This study highlighted the importance of lung sonography in mechanically ventilated patients in our set up. Ultrasound was very successful in diagnosing pneumothorax and pleural effusion. Data regarding consolidation and interstitial syndrome was also encouraging but need careful interpretation of results due to false positive and negative cases and require further attention from future researchers.

CONCLUSION

Point of care ultrasound of lung and pleura can provide valuable accurate information in a timelier manner in mechanically ventilated patients and results are almost equivalent to CT scan. The skills required to acquire and interpret ultrasound images can be learned with focused

training and should be incorporated into the critical care medicine syllabus in the future.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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