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Radio Diagnosis

Comparison of HRCT with Lung Sonography in the Diagnosis of Pulmonary Edema & ILD

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Abstract **Original Research Article**

Introduction: **Pulmonary Edema** is defined as fluid accumulation in the lungs causing change in the normal balance between the air & fluid, create a reverberation phenomenon represented by multiple B-lines. Normal lung appears on Lung Sonography as "black". Pulmonary Edema on Lung Sonography appears as "black & white" or "white" lung, whereas on HRCT it appears as septal thickening & GGO's. ILD is characterized by distortion of airways & interstitium, followed by fibrosis. ILD on Lung Sonography represented as multiple, bilateral B-lines due to pulmonary fibrosis. Whereas ILD on HRCT appears with septal thickening, GGO's, traction bronchiectasis & honeycombing. ***Objective:*** To evaluate the significance of B-lines & compare the sensitivity of Lung Sonography & HRCT in the diagnosis of Pulmonary Edema & ILD. ***Methodology*:** In a retrospective case control study, 50 subjects diagnosed as Pulmonary Edema & ILD by HRCT were compared on Lung Sonography for evaluating the distance between B-lines. ***Results*:** The B7 lines correlated with Interlobular septal thickening, whereas B3 lines correlated with GGO's on HRCT chest. Lung Sonography have 72% sensitivity and 46% diagnostic accuracy in ILD patient and Lung Sonography have 80% sensitivity and 54% diagnostic accuracy for pulmonary Edema as compare to HRCT. ***Conclusion:*** The sonographic features of Pulmonary Edema & ILD are characteristic, but non-specific. B-lines can be used as a bedside and alternative monitoring tool for Pulmonary Edema**.** Lung Sonography is an attractive & promising technique, which may become an important clinical tool to be integrated with HRCT and PFT in the screening & follow-up of Pulmonary Edema and ILD.

Keywords: B7 lines (distance between B-lines are 7 in mm), B3 lines(distance between B-lines are 3 in mm),GGO's, Pulmonary Edema, ILD.

INTRODUCTION

Pulmonary Edema is defined as abnormal accumulation of fluid in the extravascular compartments of the lung. The multiple & small air-fluid interfaces presenting in the lung periphery, create multiple B-lines on the screen [1].

ILD are characterized by distortion of airways & interstitium, determined by a first stage of alveolitis followed by a stage of fibrosis. The Lung Sonography assessment is determined by the presence of B-lines, generated from fibrosis of sub-pleural interlobular septa at the lung surface interface [2, 3].

B lines are vertical, hyperechoic, reverberation artefacts that arise from the pleural & spreading up to the edge of the screen without fading, which is originating from water-thickened or fibrosis of interlobular septa & move synchronously with respiration [4]. The distance between each two adjacent B-lines was measured in milliliters.

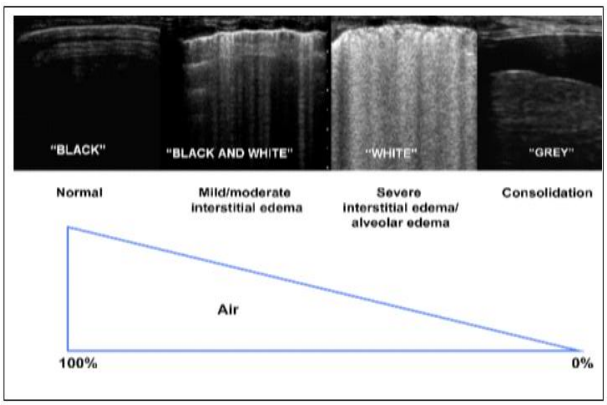

Fig-1: Physical basis of Lung Sonography (The less air is in the lung, the easier is the detection of abnormalities)

Modified from Luna Gargani *et al*. [3]

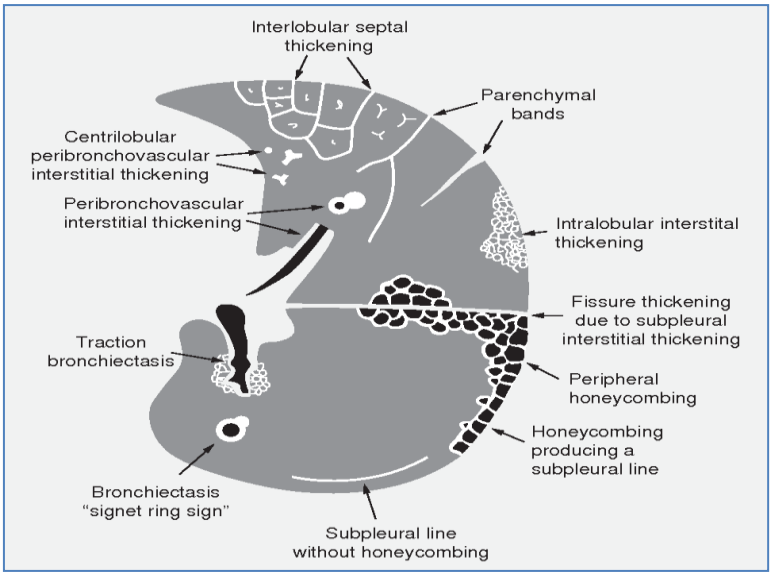

Fig-2: Linear and reticular opacities visible on HRCT

Other Lung Sonography signs may also help to differentiate the etiology of B-lines: in patients with congestive Heart failure, no pleural alterations are generally detectable. Whereas in ARDS, B-lines are often associated with thickening of the pleura due to small sub-pleural consolidations [5].

METHODS AND MATERIALS

This retrospective case control study was carried out in Department of Radio-diagnosis at Index Medical College Hospital and research centre Indore. All ages and both sexes with informed consent are including in the study excluding Paediatric age. 50 patients with Pulmonary Edema & ILD (diagnosed on HRCT) underwent Lung Sonography for assessment of presence of B-lines and the distance between them. These findings were compared with that of HRCT findings like Interlobular septal thickening, GGO's, traction bronchiectasis & honeycombing.

Scan Technique

HRCT Chest examination at full inspiration was performed by standard protocol using Somatom definition AS 64 Slice CT scanner.

All the patients underwent Lung Sonography examination using an ultrasound (siemens acusonX 300) equipped with a 3.5-MHz convex probe. The scanning was performed using the intercostal spaces as acoustic windows with the patient in a sitting or supine position rising his arms above his head to widen the intercostal space.

Lung Sonography technique that should be employed in our study is the eight-zone examination, consisting of scanning four intercostal scans/ chest areas per side: areas 1 and 2 denote the upper anterior and lower anterior chest, whereas areas 3 and 4 denote the upper lateral & basal lateral chest, respectively.

RESULTS

This study was carried out on 50 patients (25 of ILD & 25 of Pulmonary Edema) with 32 men and 18 women (Table No. 1).

Table-1: Sex Distribution in patients of ILD & Pulmonary edema

Gender	Proportion of ILD & Pulmonary Edema	%
Male	32	64
Female	18	36
Total	50	100

From this table we can draw conclusion that, ILD and Pulmonary Edema are more common in male as compare to female.

Pulmonary edema
Using HRCT

- Interlobular septal thickening, peri bronchovascular marking, noted in 20 patients (80%) of Pulmonary Edema.
- GGO's & increased peri-bronchovascular marking noted in 5 patients (20%) of total Pulmonary Edema.

Using Lung Sonography

- The B 7-lines correlated with Interlobular septal thickening noted in 20 patients (80%) of Pulmonary Edema cases.
- The B3-lines seemed to be more numerous & making the surface of the lung more hyperechoic correlated with areas of GGO's on HRCT noted in 5 patients (20%) of Pulmonary Edema cases.

Table-2: Screening Test Evaluation for Pulmonary Edema

Lung Sonography	HRCT Chest		
Distances between B-line	Pulmonary Edema	ILD	Total
>7mm	20	18	38
<7mm	5	7	12
Total	25	25	50

20 out of 25 patients have B7-line which corresponds to interlobular septal thickening on HRCT.

Table-3: Results for Pulmonary Edema (Applying Wilson Score)

Lung Sonography	Estimate lower	Upper 95% CI
Sensitivity	80 %	91.14%
Specificitiy	28 %	47.58%
PPV	52.63 %	67.52%
NPV	58.33 %	80.67%
Diagnostic Accuracy	54%	67.03%

- Lung Sonography has 80% sensitivity, 28% specificity and 54% diagnostic accuracy for pulmonary Edema as compare to HRCT.

ILD

Using HRCT

- GGO's pattern was observed in 7 patients (28%)
- Reticular & Honeycombing pattern in 18 patients (72%)

Using Lung Sonography

- The B7-lines correlated with extensivFe fibrosis & reticular pattern on HRCT noted in 18 patients (72%) of ILD cases.
- The B3-lines correlated with areas of GGO's on HRCT, noted in 7 patients (28%) of ILD.

Table-4: Diagnostic or Screening Test Evaluation for ILD

Lung Sonography	HRCT Chest		
Distances between B-line	ILD	Pulmonary Edema	TOTAL
>7mm	18	20	38
<7mm	7	5	12
Total	25	25	50

- 18 out of 25 ILD patients have B7-line which correspond to fibrosis, reticular pattern and Honeycomb on HRCT.

Table-5: Results for ILD (Applying Wilson Score):

Lung Sonography	Estimate Lower	Upper 95% CI
Sensitivity	72%	85.72%
Specificity	20%	39.13%
PPV	47.37%	62.74%
NPV	41.67%	68.05%
Diagnostic Accuracy	46%	59.60%

- Lung Sonography has 72% sensitivity, 20% specificity and 46% diagnostic accuracy in ILD patient as compare to HRCT.

Table-6: Comparative Findings in Lung Sonography & HRCT Chest:

		Lung Sonography	HRCT Chest
1.	Interlobular septal thickening	20	20
2.	Reticular opacities	18	18
3.	GGO's	12	12
4.	Honeycombing	0	18
5.	Nodular opacities	0	12
6.	Peribronchial cuffing	0	4
7.	Traction bronchiectasis	0	18

- Most common abnormality can detect on Lung Sonography are interlobular septal thickening, Reticular opacities and GGO's whereas Lung Sonography have inherent lack of sensitivity for Nodular opacities, Peri-bronchial cuffing & Traction bronchiectasis.

Case No.1

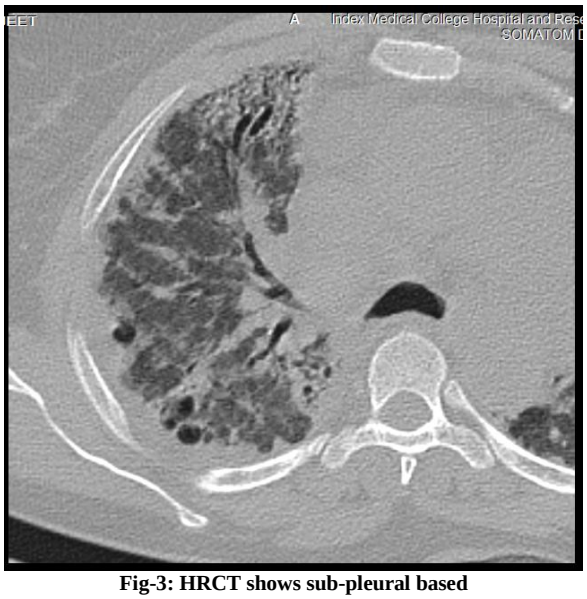

Fig-3: HRCT shows sub-pleural based honeycombing,intralobular septal thickening & traction bronchiectasis

Fig-4: HRCT of patient shows multiple areas of cystic bronchiectasis

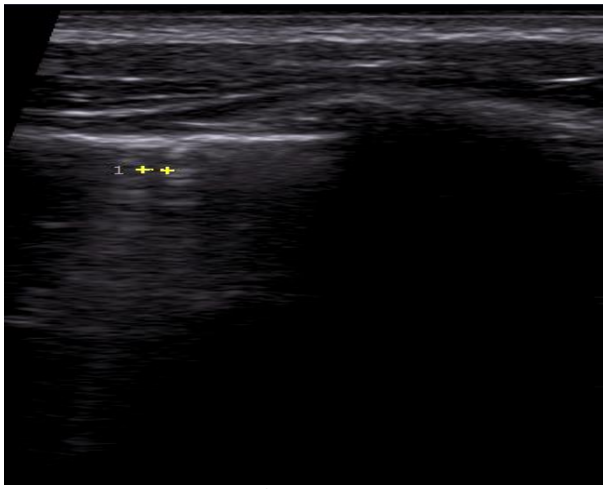

Fig-5: Lung Sonography of above patient multiple B-lines at a distance < 3mm

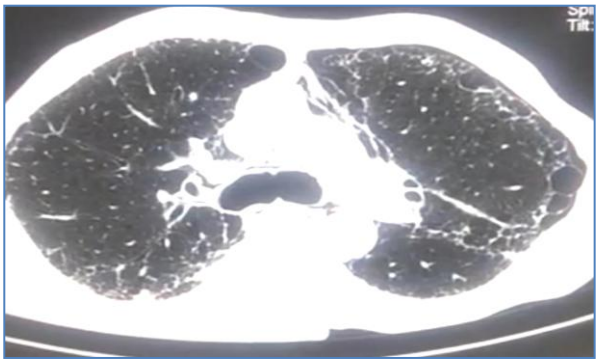

Fig-6: HRCT scan showing reticular pattern & honeycombing in bilateral basal lobes.

Fig-7: Lung Sonography of above patient showing multiple B7-Lines

Fig-8: HRCT is showing GGOs in bilateral basal lobes (more on left side)

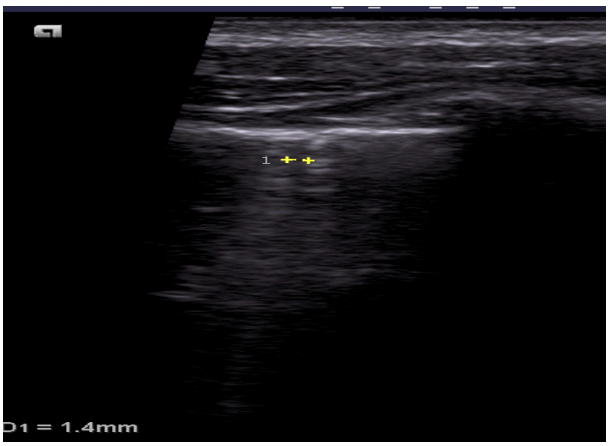

Fig-9: Lung Sonography of above patient showing multiple B3 lines

DISCUSSION

In Pulmonary Edema, multiple B7-lines are seen, caused by thickened interlobular septa, characterizing interstitial edema, while B3-lines are caused by ground glass areas characterizing alveolar Edema. Lung Sonography can monitor pulmonary congestion through the evaluation of B-lines [6]. The number, diffusion and intensity of B lines correlate with both the radiologic and invasive estimate of extravascular lung water.

In our study of Pulmonary Edema, HRCT was able to show Interlobular septal thickening, GGO's and increased Peri bronchovascular marking in the Pulmonary Edema patients but Lung Sonography was unable to detect pulmonary vascular changes. HRCT shows peri bronchial cuffing in 8% of cases while Lung Sonography was unable to detect these changes.

In our study of ILD cases, 24% had nodular opacities, 36% had honeycombing and Traction bronchiectasis in their HRCT, while Lung Sonography could not detect them. These results were compatible with the Ali A. Hassan et al (In 2014) studies, demonstrate B3 lines correlated with GGO's and B7 lines correlated with extensive fibrosis and honey combing[7].

The inference that we draw from this study is that HRCT is much more sensitive & specific than Lung Sonography in the assessment and diagnosis of patients with Pulmonary Edema and ILD. Even when both modalities were able to detect the findings like interlobular septal thickening, Reticular pattern & GGO's but HRCT could characterize the abnormality and specify its location much more accurately. Hence, HRCT seems to be the Gold Standard investigation of choice for the evaluation ILD & Pulmonary Edema.

Advantages of over HRCT

B-lines have been proposed as a bedside, easy-to-use, alternative diagnostic tool for clinically monitoring pulmonary congestion in Heart failure

patients [8], as they clear after adequate medical treatment.

It is a bedside procedure widely available, easily performed, inexpensive, requires neither ionizing radiation nor a contrast medium and is therefore readily and largely accepted by the patient.

Limitations of the Lung Sonography

The main limitation of B-Lines is the lack of specificity and essentially patient dependent. B–Lines can have various aetiologies (interstitial Edema, interstitial fibrosis) [9, 10], & differentiating them in clinical practice can sometimes be difficult.

Lung Sonography had been performed on patients already diagnosed with Pulmonary Edema based on chest HRCT, and this may be considered a bias for the interpretation of the lung ultrasound patterns.

CONCLUSION

Lung Sonography is an attractive and promising technique, which may become an important clinical tool to be integrated with HRCT and PFT in the evaluation of ILD. B-lines cannot discriminate the early cellular inflammation from the chronic fibrotic phase in ILD.

B-Lines assessment by Lung Sonography represents a new, helpful tool for the cardiologist, to be employed at all stages of the management of pulmonary Edema due to Heart Failure patients, and for the differential diagnosis of dyspnea.

Moreover, Lung Sonography outperforms conventional radiology for the diagnosis of early signs of pulmonary congestion and should always be considered when radiologic signs are not detected on Chest X- ray but heart failure is still considered a possibility. Indeed, the ultrasound signs of the interstitial syndrome, the B-Lines, are also detected in other pulmonary conditions. Hence, HRCT Chest is essential to the diagnostic work-up.

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