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Original Article

Diagnostic performances of high resolution trans-thoracic lung ultrasonography in pulmonary alveoli-interstitial involvement of rheumatoid lung disease

Miramir Aghdashi[1], Behdad Broofeh[2], Afshin Mohammadi[3]

[1]Department of Rheumatology, Urmia University of Medical Sciences, Urmia, West-Azerbaijan, Iran; [2]Resident of internal medicine, Urmia University of Medical Sciences, Urmia, West-Azerbaijan, Iran; [3]Department of Radiology, Urmia University of Medical Sciences, Urmia, West-Azerbaijan, Iran

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Abstract: Introduction: Alveolointerstitial involvement is a common manifestation in patients with connective tissue disorders. The aim of our study is to investigate the utility of modified TTUS scoring system compared with HRCT findings of pulmonary involvement in rheumatoid lung disease. Material and Methods: Thirty one consecutive patients with a suspected diagnosis of rheumatoid lung involvement were examined with high resolution transthoracic ultrasonography for detecting of ultrasonographic comet tail signe as a ultrasonographic marker of lung involvement in alveolointerstitial involvement in rheumatoid lung disease and the results of them were compared with High resolution computed tomography as gold standard method for diagnosis of lung involvement in this patients. Results: In comparison with HRCT as gold standard method, the sensitivity, specificity, positive and negative predictive value of TTUS was 73.58%, 88.23%, 95.12% and 51.72% respectively. Conclusion: Modified TTUS can be a useful imaging modality in the evaluation of even early stages of pulmonary involvement in rheumatoid lung disease.

Keywords: Ultrasound, lung, comet tail

Introduction

Alveolointerstitial involvement is a common manifestation in patients with connective tissue disorders [1]. Pulmonary involvement is reported in 70% to 100% of patients with systemic sclerosis in autopsy series [2]. Pulmonary fibrosis is one of the main causes of morbidity and is the leading cause of mortality in patients with SSc.

High-resolution CT (HRCT) is now the gold standard method for diagnosis of SSc related interstitial lung disease [3]. The role of trans-thoracic lung ultrasound (TTUS) in the assessment of a various pulmonary conditions has been reported previously [4-6]. The US feature of pulmonary fibrosis is determined by the detection and quantification of ultrasound lung comet tail singe, which is generated by the reflection of the US beam from thickened sub-pleural interlobar septum. In all of the previous study extensive assessment with examination of many intercostals spaces is needed that is time consumption [4-6]. We decided to examine selective intercostals spaces (10 locations) as modified TTUS and compared the results of this new scoring system with HRCT findings. The aim of our study is to investigate the utility of modified TTUS Comet tails scoring system compared with HRCT findings of pulmonary involvement in rheumatoid lung disease.

Materials and methods

Thirty one consecutive patients with a suspected diagnosis of rheumatoid lung involvement referred to Rheumatology outpatients Clinic of the Urmia University of Medical Sciences were included in the study. The diagnosis of each rheumatologic disorder was made according to the ACR classification criteria. Inclusion criteria were: confirmed diagnosis of rheumatologic disease and chest HRCT performed no longer than

one week prior to the beginning the study. Patients with a history of pulmonary neoplasia and suspected to lymphangitis carcinomatosa or other causes of interstitial fluid, such as, heart failure, asthma or pulmonary edema and history of smoking were excluded from the study.

After complete history tacking all the patients were completely evaluated by a one cardiologist, one pneumologists and one rheumatologist for confirming the diagnosis and excluding the other cause of pulmonary and cardiac inducing US B-Line. The confirmation of exclusion criteria's were made mainly on the basis of clinical aspects and echocardiogram to rule out cardiac disease.

All of the Chest HRCT and transthoracic US examinations were performed at the Radiology Departments of the Imam Khomeini University hospital. All chest HRCT examinations were interperateted and scored by one Radiologists who had enough experience in pulmonary HRCT manifestation of interstitial lung disease and was blinded to the study design.

All TTUS examinations were performed by one another radiologist who has 8 years of experience in TTUS pulmonary assessment and intervention. TTUS examiner was blinded to both clinical data's and HRCT findings. Moreover, patients were asked not to talk about their disease with US examiners.

Ethical approval was obtained from the University Ethics Committee and informed consent was obtained from all patients.

Chest HRCT examination was performed by using a MDCT (GE Light Speed RT 16 CT Scanner; GE, Milwaukee, WI) Scanner at full inspiration in the supine position (120 kV and 300 mAs) .The lung parenchyma was imaged from apex to base with a table increment of 10 mm and a slice thickness of 1 mm with a bone plus reconstruction with lung window. The intravenous contrast material was not used. The prone sections were performed to exclude gravity dependent perfusion in cases showing increased opacification in the posterior portion of lung base.

Ultrasound examination

TTUS examination was performed using a siemense sonoline G-40 (Siemense, Germany) equipped with a 7 to 10 MHz broad band linear multi-frequency transducer. Patients were examined in supine position for assessment of anterior chest wall and in sitting position for assessment of posterior chest wall. Ultrasound images were obtained by moving the probe longitudinally along anatomical reference lines.

We performed the modified TTUS B-lines assessment which consisted of a total of 10 intercostals space (ICS) bilaterally. In anterior chest wall we examined the fourth ICS along the mid-clavicular line and the anterior and mild-axillary lines. In the posterior chest, the eighth ICS in the posterior axillary lines and sub-scapular area were examined. These 10 sites were selected according to higher prevalence of involvement in interstitial lung disease and accessibility by TTUS. The ultrasonographic investigator was unaware of chest HRCT results and clinical data of the patients.

In TTUS, the artifact generated from the thickened interlobular septa at lung surface was considered as TTUS B-line. TTUS B-Line reveals as a hyper echoic narrow-based reverberation artifact that generally are not visible in normal lung parenchyma (**Figure 1**).

We considered more than 5 TTUS B line in ultrasonography as pulmonary involvement and positive results (**Figure 2**)

Statistical analysis was performed using SPSS software, version 16. Descriptive results were expressed as mean and standard deviation (SD). *P*-values below 0.01 were considered statistically significant. We calculate sensitivity specificity and positive and negative predictive value of TTUS in comparison with HRCT as gold standard.

Results

Thirty one consecutive patients (26 females and 5 males) with a diagnosis of rheumatologic lung disease were included in our study. Mean ± SD age was 48.29 ± 9.7 years (ranging from 30 to 66 years) and the mean ± SD disease duration was 68 ± 23.1 months (range 4 to 122 months).

The underlying disease was progressive systemic sclerosis in 19 patients (61.29%), Rheumatoid arthritis in 8 patients (25.8%), Overlap Syndrome in 2 patients (6.4%) and 1

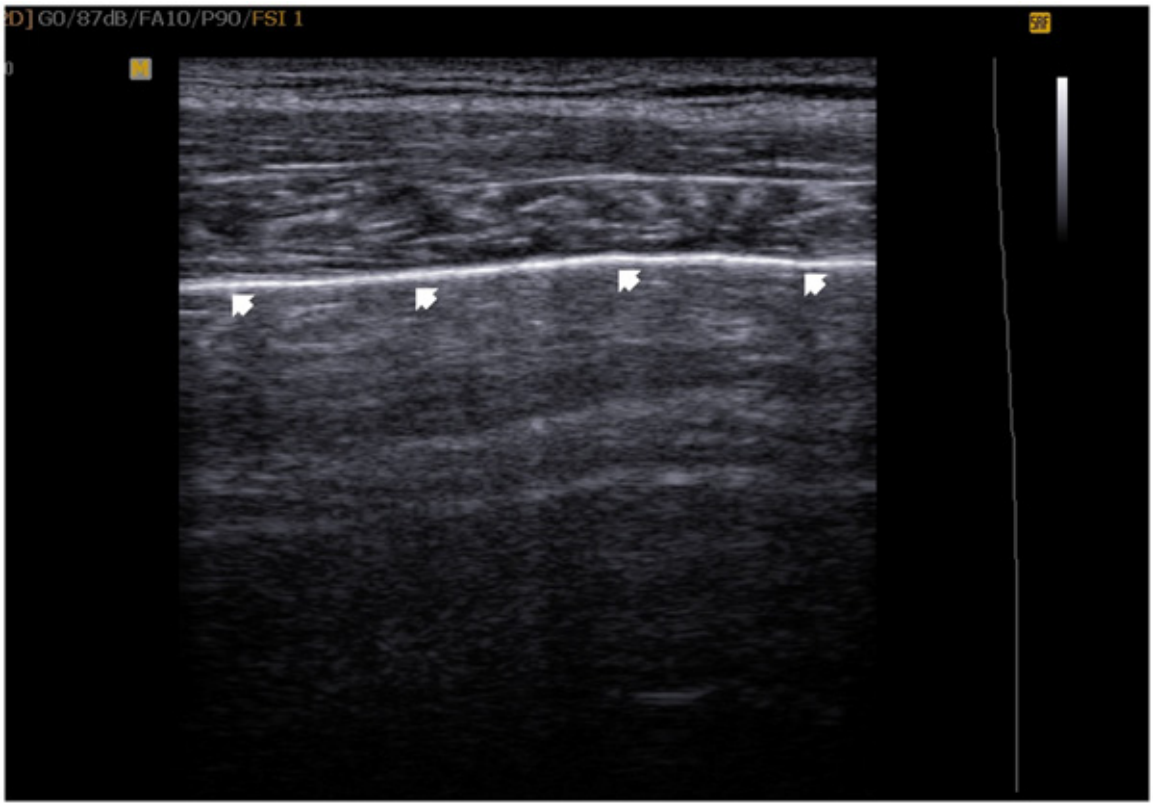

Figure 1. Ultrasonographic image shows smooth echogenic normal lung surface (arrow).

patient (3.2%) each had Sojgren and Dermatomyositis.

A total of 310 ICS were evaluated for the modified TTUS B-lines assessment.

In comparison with HRCT as gold standard method, the sensitivity, specificity, positive and negative predictive value of TTUS was 73.58%, 88.23%, 95.12% and 51.72% respectively.

Discussion

Currently, chest HRCT is considered the "gold-standard" method for the diagnosis of disease activity in both early pulmonary involvement and subclinical lung involvement [3, 4].

Transthorasic chest US previously described for assessing some pulmonary condition such as pulmonary interstitial edema, atelectases, and pleural effusions and to guide for interventional lung and pleural lesion biopsy [7-13]. Currently the role of TTUS for investigation of pulmonary fibrosis in systemic sclerosis has been described [4].

The results of current research on TTUS in pulmonary alveolointerstitial disease showed a good correlation with HRCT as a "gold standard" method. US can be a valuable diagnostic modality for the chest assessment because it is widely available, inexpensive, a bedside procedure and is a safe method of assessment. The lung surface can be easily investigated by TTUS, so the Comet tail sign "artifacts" are quickly detectable with small surface high frequency probe [14].

Our problem with previous US scoring systems is that it needs to assess the US B-lines more than 50 LIS, which is time consuming and is difficult to be a daily practical clinical method [3-6]. In our study US B-lines assessment is composed of 10 ICS, chosen on the basis of the major prevalence of lung segment involvement during HRCT assessment in patients with scleroderma. Diagnosis and quantification of lung involvement in patients with SSc has therapeutic and prognostic significance [4, 15, 16].

HRCT is the gold-standard method for detection and quantification of lung fibrosis in SSc

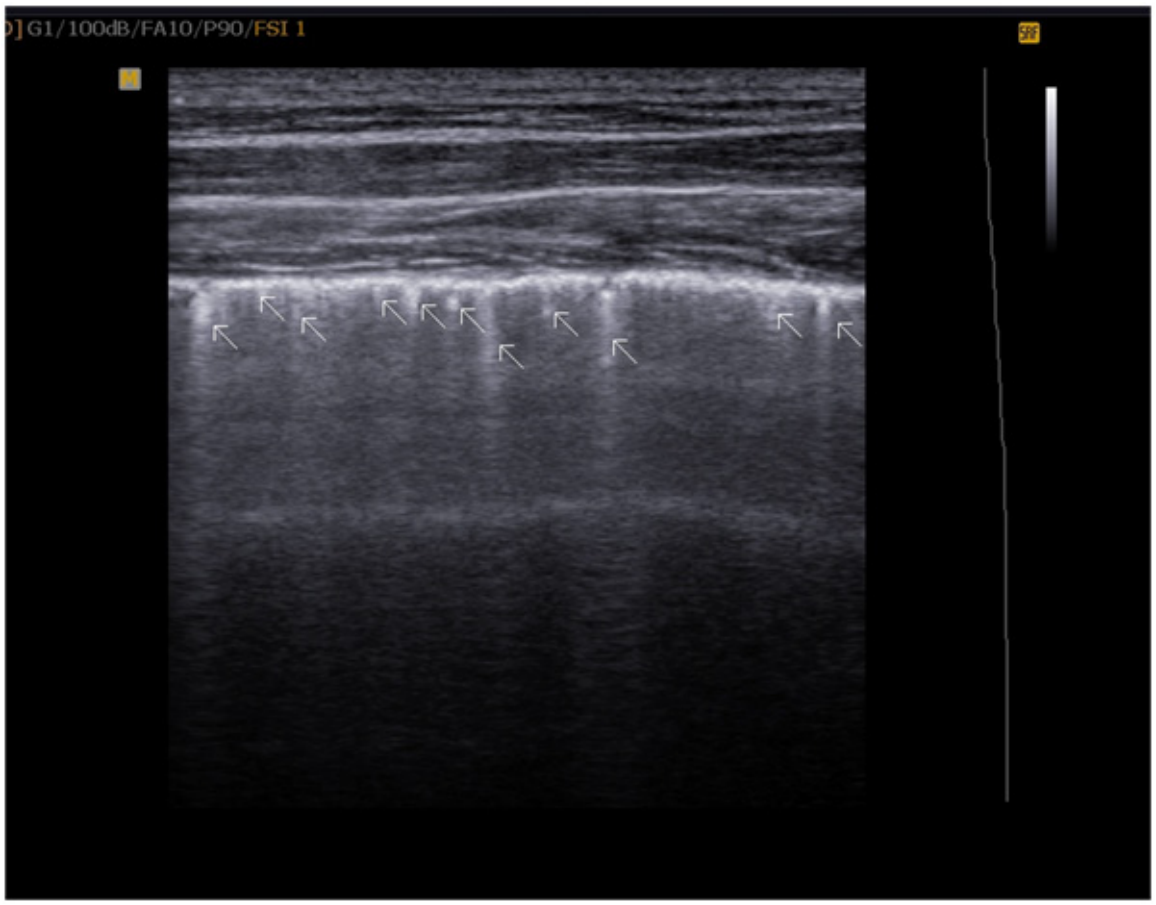

Figure 2. Ultrasonographic image shows multiple echogenic comet tail singe (arrows) in a patient with parenchymal lung involvement in systemic sclerosis.

especially in early stages of lung involvement [17, 18]. According to our study, TTUS can be helpful in identifying and quantifying pulmonary fibrosis, as assessed by HRCT. In a view point of cost effectiveness, accessibility and its rapid performing time (<6 min) of TTUS the clinical impact of this method will be magnified.

It seems that HRCT remains the gold-standard method for assessing alveolointerstitial involvement because only HRCT can allows the investigation of the entire lung parenchyma, in comparison with HRCT, TTUS can allows assessing of only the surface of the lung and may be useful as an adjunctive method for the follow-up of SSc patients especially during treatment, because it can reduce radiation exposure especially in young women who have more cancer risk than men for any radiation [4].

This is the first study evaluating the presence of alveolointerstitial involvement as a US B-Lines by Modified TTUS in patients with rheumatologic disease, in comparison with the HRCT as gold-standard method. TTUS usually performed by low to medium (3.5-5 MHz) frequency transducers [13, 19] whereas high frequency linear transducers are considered to be the best tool for investigation of pleural line. The major differential diagnosis of US B-Line that should be keeping in mind arises from cardiogenic causes of US B-Line due to thickened interlobar septa as pulmonary edema [20].

The limitation of our study is, in our study we evaluated only selected patients with SSc and fibrotic change inducing US B-line. It is obvious that in a non selected population, Difficulties of diagnosis of pulmonary alveolointerstitial involvement according to US B-Line will arise.

Conclusion

Alveolointerstitial involvement in patients with rheumatoid lung disease may be diagnosed by TTUS even in early stage. The presence US

B-lines at TTUS examination have good sensitivity for diagnosis of alveolointerstitial involvement at HRCT. Modified TTUS can be a useful imaging modality in the evaluation of even early stages of pulmonary involvement in SSc patients.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Afshin Mohammadi, Department of Radiology, Urmia University of Medical Sciences, Urmia, West-Azerbaijan, Iran. Phone: +98441-235356; Fax: +984413455810; E-mail: Mohamadi_afshin@yahoo.com; afshin.mohdi@gmail.com; ma.aghdashi@yahoo.com; b.broofeh@yahoo.com

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