Lung Ultrasound and Pulmonary Function Test in Cirrhotic Patients

P. Osni Leão Perin[a,*], I. de Fátma Ferreira Santana Boin[b], A.M. Oliveira da Silva[c], F. Chueiri Neto[a], and L.C. Martins[d]

[a]General Intensive Care Unit, Surgery Department, State University of Campinas, Campinas, Brazil; [b]Liver Transplantation Unit, Surgery Department, State University of Campinas, Campinas, Brazil; [c]Gastrocentro, Surgery Department, State University of Campinas, Campinas, Brazil; and [d]Internal Medicine Department, State University of Campinas, Campinas, Brazil

ABSTRACT

Lung ultrasound (LU) is useful in the diagnosis of pulmonary interstitial-alveolar syndrome (IAS) when B-lines are detected. Its prevalence and effect in lung function is not well studied in cirrhotic patients. The objective of this study was to detect the prevalence of interstitial-alveolar involvement with LU and correlate with pulmonary function test to distinguish the effect of ascites and B-lines in pulmonary function. This was an observational single-center study with 49 patients listed for liver transplantation submitted for LU and pulmonary function tests. Patients were divided into 4 groups: no ascites and no B-lines ($n = 19$), B-lines only ($n = 19$), ascites only ($n = 6$), and ascites and B-lines ($n = 5$). There was a worse forced vital capacity (FVC) in patients with B-lines only (76.1% ± 9.2; $P =$ .0058) and ascites only (66.8% ± 10.2; $P = .0010$). 1-second forced expiratory volume (FEV_1) also was lower in patients with B-lines only (78.5% ± 10.3; $P = .0001$), ascites only (71.3% ± 13.2; $P = .0004$), and B-lines and ascites (74.2% ± 7.6; $P = .0035$). Model for End-Stage Liver Disease score was worse in the group with ascites and B-lines (22.4 ± 10.1; $P = .0229$). B-Lines reduced FVC and FEV_1 in our study and may be an independent factor in worsening pulmonary function in these patients.

LUNG ultrasound (LU) is a powerful tool in the diagnosis of pulmonary interstitial-alveolar syndrome (IAS) [1]. Ultrasound waves are almost completely reflected by normal aerated lungs, generating reverberation artifacts called A-lines; however, interstitial-alveolar involvement (hemodynamic, inflammatory, or fibrotic) shows other artifacts known as B-lines. These are vertical sonographic artifacts that arise from the pleural line, move during the respiratory cycle, are well defined, continue without fading until the edge of the screen, are hyperechoic, and erase the A-lines [2].

Cirrhosis has well established effects on respiratory function as a consequence of pulmonary edema, hepatic hydrothorax, atelectasis, portopulmonary hypertension, and hepatopulmonary syndrome [3]. Ascites is a common complication of patients with cirrhosis and it may also cause a negative impact in the pulmonary function test (PFT), as shown in some small studies [4,5], but the results do not have full agreement.

In the present study, we proposed the use of LU to detect the prevalence of interstitial-alveolar involvement (hydrostatic fibrotic or inflammatory) in cirrhotic patients and correlate it with PFT in different groups to distinguish the real effect of ascites and the contribution of B-lines in pulmonary function.

METHODS

This was an observational study performed over a period of 14 months. Fifty-six patients were evaluated according to the following inclusion criteria: adults with end-stage liver disease listed for liver transplant at the Clinical Hospital of State University of Campinas. The exclusion criteria were fulminant hepatitis, patients with pleural effusion, cardiomyopathy with ejection fraction <50%, and signs of pulmonary hypertension on echocardiography. Patients with hypoxemia also were excluded.

The study was approved by the local Ethics Committee, and all of the patients gave informed consents to participate in the study. The

*Address correspondence to Paulo Osni Leão Perin, State University of Campinas, Amélia Maria de Paula Venturini Street, 121, Campinas, Brazil, CEP: 13086-061. E-mail: pauloleaoperin@gmail.com

0041-1345/17
http://dx.doi.org/10.1016/j.transproceed.2017.01.046

recruitment was made during routine consultation at clinic. After reading and signing the consent terms, patients were submitted to the tests, including: personal data collection, Model for End-Stage Liver Disease (MELD) calculation [6], PFT with measurement of forced expiratory volume of 1st second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio, pulse oximetry measurement, abdominal ultrasound exam to detect ascites, and LU.

Pulmonary Function Test

PFT measurements were performed with the use of Easyone Diagnostic Spirometer (Zurich, Switzerland) while the patients were sitting and at rest. First, patients were told to take a deep breath and then to take the mouthpiece in between their lips and make a forced and fast expiration until their lungs were completely emptied, and then to take a deep breath again. These maneuvers were performed until 3 technically appropriate curves were obtained, and the highest values were chosen. Measurements of FVC, FEV_1, and FEV_1/FVC were performed. FVC is accepted as the maximum volume of air that can be expired during a forced expiration. FEV_1 is the amount of air that is exhaled in the 1st second during the FVC maneuver. The FEV_1/FVC ratio is, however, a measurement that shows the presence of an obstruction to the air flow. The results were expressed in percentages according to methodologic, epidemiologic, and statistical predictors [7].

Pulse Oximetry

Pulse oximetry was performed in supine and upright positions (after 1 minute for each position) with the use of the Nonin Onyx 9559.

Ascites Diagnosis

Ascites investigation was performed with the use of Fujifilm Sonosite Titan I (Bothell, Washington) with 6 MHz convex transducer and was considered to be positive when the presence of liquid was detected in the right or left upper abdominal quadrant [8].

Lung Ultrasound

LU was performed by the same investigator unaware of the PFT findings with the use of the same ultrasound machine and transducer used to detect ascites. The patients were in supine position with elevated head during the exam. There are several approaches to performing LU [9]. In this study we followed the author's preference and experience. First, the presence of pleural effusion was observed at the thoracic-abdominal transition bilaterally, then each hemithorax was divided into 6 chest areas per side: anterior (midclavicular line), medium (anterior axillary line), and posterior (posterior axillary line), and then into superior and inferior (dividing the chest wall from the clavicle to the costal margin). We considered B-lines to be significant when $\geq$3 lines appeared in a transversal view between 2 ribs. We also classified these findings as normal (absence of B-lines, $<$3, or only 1 quadrant involved in both sides) or positive ($\geq$3 bilateral B-lines) [10].

Statistical Analysis

The SAS System for Windows (Statistical Analysis System) version 9.4 (SAS Institute, Cary, North Carolina) was used to perform analysis of variance and Kruskal-Wallis tests to compare groups. The level of significance was 5%.

RESULTS

A total of 59 patients were evaluated; 3 of these had hypoxemia and 7 had pleural effusions and were excluded from the analysis. The results are presented in Table 1. For the 49 remaining patients we found the following results: ascites was detected in 11 patients (22%) and B-lines in 24 patients (49%).

Based on these results, patients were divided into 4 groups: ascites absent (group NoA) without (group NoA-NoB) or with (group NoA-B) B-lines and ascites present (group A) without (group A-NoB) or with (group A-B) B-lines.

The comparison among FVCs showed a mean FVC of 88.3% of predicted in group NoA-NoB and 76.1% of predicted in group NoA-B ($P = .0058$). In group A-NoB we found a mean FVC of 66.8% and in group A-B 75.6%, showing no difference ($P = .1998$; Fig 1).

Comparing group NoA-NoB with group A-NoB showed worse FVC, with a mean of 66.8% of predicted for the latter ($P = .0010$). There was no difference among the remaining groups when comparing FVC values (Fig 1).

When comparing FEV_1 values, a mean of 94.8% of predicted was found in group NoA-NoB and 78.5% of predicted in group NoA-B ($P = .0001$). In group A-NoB we found a mean FEV_1 of 71.3% and in group A-B 74.2%, showing no difference ($P = .7901$; Fig 2).

Compared with group NoA-NoB with a mean FEV_1 of 94.8%, group A-NoB showed worse FEV_1 with a mean of 71.3% of predicted ($P = .0004$). The comparison FEV_1 between group NoA-NoB and group A-B (mean FEV_1 of 74.2%) showed a significant difference ($P = .0035$). There was no difference among the remaining groups when comparing FEV_1 values (Fig 2).

Table 1. Demographic and General Results

Characteristic	*n*	%	Mean ± SD
Sex			
Male	38	77.6	–
Female	11	22.4	–
Age (y)	49	–	56.80 ± 6.32
Ascites	11	22.4	–
Diffuse B-lines	24	49	–
MELD score	49	–	15.88 ± 6.55
FVC (% of predicted)	49	–	79.61 ± 13.11
FEV_1 (% of predicted)	49	–	83.51 ± 14.47
FEV_1/FVC	49	–	105.04 ± 6.66
Diagnosis			
Alcohol	8	16.3	–
Autoimmune	1	2.0	–
Cryptogenic	4	8.16	–
Polycystic disease	1	2.0	–
Hepatitis C	12	24.4	–
Carcinoma and hepatitis C	17	34.6	–
Hepatitis B	2	4.0	–
Carcinoma non-C hepatitis	4	8.1	–

Abbreviations: MELD, Model for End-Stage Liver Disease; FVC, forced vital capacity; FEV_1, forced expiratory volume in 1 second.