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ORIGINAL ARTICLE

Respiratory muscle strength, hypoxemia and dyspnea in liver cirrhosis patients

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KEYWORDS

Cirrhosis;
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Abstract *Background:* Respiratory muscle strength, occurrence of chronic dyspnea and hypoxemia are still subjects of debate in liver cirrhosis. The loss of muscle mass in cirrhotic patients may affect respiratory muscles thus contributing to chronic dyspnea in those patients.

Objective: To evaluate respiratory muscle strength, occurrence of hypoxemia and chronic dyspnea and their interrelationships in cirrhotic patients.

Patients and methods: One hundred HCV liver cirrhosis patients were recruited. Liver profile, serum creatinine, arterial blood gases (ABG), spirometry, maximal inspiratory (PiMAX) and expiratory (PeMAX) pressures were measured. Grading of dyspnea was done using the modified medical research council (mMRC) scale. The model for end-stage liver disease (MELD) score was calculated for every patient.

Results: Patients' mean MELD score was 16.9 ± 5.23. Mean mMRC score was 2.18 ± 0.81. Hypoxemia was found in 81 (81%) patients. 39 (39%) and 35 (35%) patients had low PiMAX and PeMAX, respectively, and 37 (37%) patients had low respiratory muscle strength (RMS). mMRC score correlated negatively with RMS ($r = -0.767$, $p < 0.001$) and PO_2 ($r = -0.754$, $p < 0.001$) but correlated positively with MELD score ($r = 0.9$, $p < 0.001$). MELD score correlated negatively with RMS ($r = -0.824$, $p < 0.001$) and PO_2 ($r = -0.824$, $P < 0.001$). Patients without ascites had significantly higher PO_2, PiMAX, PeMAX and RMS but lower mMRC values than ascitic patients.

Conclusion: Chronic dyspnea and hypoxemia are prevalent in cirrhotic patients and they are correlated with respiratory muscle weakness and liver disease severity. Ascitic patients have worse respiratory muscle function and are more dyspneic than non ascitic patients.

Introduction

Pulmonary symptoms and abnormalities occur commonly in patients with liver cirrhosis regardless of etiology [1]. Arterial blood gas and pulmonary function test abnormalities also are common and are found in as many as 45–50% of cirrhotic patients [2].

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Some common complications of cirrhosis may interfere with lung function: the tension of ascites moves the diaphragm upward, making the ventilatory excursions difficult and pleural effusion which occurs in approximately 5% of cirrhotic patients as a direct consequence of portal hypertension may also cause abnormalities in pulmonary gaseous exchange [3]. In addition, specific pulmonary vascular changes associated with liver disease and/or portal hypertension, i.e. hepatopulmonary syndrome and portopulmonary hypertension, are now well established [4].

Although chronic dyspnea is the predominant respiratory symptom in patients with liver disease [5], there are scarce reports on its prevalence and measurement using a widely accepted tool as the modified medical research council mMRC chronic dyspnea scale [6].

Patients with advanced liver cirrhosis are usually tiring easily, having chronic fatigue, protein wasting and muscle mass loss [7]. The loss of muscle mass may affect both peripheral and respiratory muscles [2]. Tests for measurement of respiratory pressures quantify the level of muscle weakness [8]. Due to the fact that lung complications are frequent in hepatic diseases, tests such as the measurement of maximum inspiratory (PiMAX) and expiratory (PeMAX) pressures, are important to evaluate pulmonary function and to delineate lung risk in cirrhotic patients [9]. Hence, the aim of this study is to evaluate respiratory muscle strength, occurrence of hypoxemia and chronic dyspnea and their interrelationships in cirrhotic patients.

Patient and methods

The study included 100 adult patients with confirmed HCV liver cirrhosis based on lab and radiological studies referred to for spirometry at Minoufiya University Pulmonary Function Test Unit during the period from April 2013 to April 2014 as a part of investigating the cause of dyspnea or as a part of the preoperative preparation for any operation. Inclusion criteria were: (1) age 18 years and older; (2) the ability to perform a full lung function testing satisfactorily; and (3) stable clinical and functional state for at least four weeks before testing. The exclusion criteria were: (1) cardiovascular disorders diagnosed by a cardiologist, (2) known lung disease caused by conditions other than liver, such as asthma or chronic obstructive pulmonary disease, interstitial lung disease, pleural effusion, previous upper abdominal or thoracic surgery, neuromuscular disorders, and daily use of theophylline. Patients who cannot tolerate large pressure swings in the thorax or abdomen caused by pulmonary function test maneuvers (e.g. those with aneurysm, uncontrolled hypertension, urinary incontinence), were also excluded. Before the beginning of the study, ethics approval was obtained from the Minoufiya Hospital's Review Board and a written informed consent was obtained from all patients.

Liver disease severity was assessed according to the model for end-stage liver disease (MELD, United Network for Organ Sharing modification) [10]. Serum laboratory data (used for MELD score calculation) were measured maximum ±7 d the day of respiratory testing.

Chronic dyspnea was rated according to the mMRC 5-point scale [11]. The scale comprises statements that describe almost the entire range of respiratory disability from none (Grade 0) to almost complete incapacity (Grade 4). The score is the number that best fits the patient's level of activity.

Arterial blood gas sampling was done before spirometry during rest, at room air. Hypoxemia was considered to be present when PaO_2 was <80 mmHg. Simple spirometry was measured with spirometer (Quark PFT3, COSMED, Italy). Forced expiratory flow in the first second (FEV1), and forced vital capacity (FVC) were measured. All measurements were performed according to the American Thoracic Society recommendations and expressed as the percent of predicted values based on age, sex and height. Clinically significant restrictive lung disease was defined when an abnormal FVC with normal FEV1/FVC was observed [12].

Respiratory muscle strength was assessed by measuring PiMAX and PeMAX using the same spirometer according to the published protocols [13,14]. The PiMAX/PeMAX valve was connected to the breathing valve connector on the front panel of the Quark apparatus and the flow meter was inserted into the valve. Then, the gas cylinder containing O_2 100% driving the valve was opened with the patient seated, wearing a nose clip. The PiMAX/PeMAX maneuver was to tell the patient to breathe normally for some time then inspire/expire with the maximum force against the shutter until it opens automatically. The determinations were repeated until 5 measurements varying by $<5\%$ and the best value achieved was considered in the data analysis. Respiratory muscle strength was calculated as the arithmetic mean of PiMAX (% of predicted) and PeMAX (% of predicted).

Statistical methodology

Using SPSS version 17 (SPSS Inc., Chicago, IL, USA), data were described as mean ± standard deviation for quantitative variables and as frequency and percentage for qualitative variables. Student's *t*-test and Pearson correlation coefficient were used. P value <0.05 was considered significant.

Results

The current study included 100 patients with confirmed HCV liver cirrhosis. Patients with a mean age of 49.6 ± 8.62 years included 61 (61%) males and 39 (39%) females. 36 (36%) patients were not ascitic while 64 (64%) patients had ascites. 18 (18%) patients were Child A, 35 (35%) Child B and 47 (47%) Child C. Patients' mean MELD score was 16.9 ± 5.23 (Table 1).

Patients' mean mMRC score was 2.18 ± 0.81 with 44 (44%) patients reporting grade 2 dyspnea, 33 (33%) patients grade 3 dyspnea, 19 (19%) patients grade 1 dyspnea while 3 (3%) patients grade 4 dyspnea. An analysis of ABG findings in our patients revealed hypoxemia in 81 (81%) patients (Table 2).

As regards pulmonary function tests and respiratory muscle strength assessment: 39 (39%) patients had low PiMAX (defined as PiMAX < 80% predicted), 35 (35%) patients had low PeMAX (defined as PeMAX < 80% predicted) and 37 (37%) patients had low RMS (defined as RMS < 80% predicted) (Table 3).

Concerning the interrelationship between dyspnea, hypoxemia, respiratory muscle strength (RMS) and liver disease