Original Article

Impact of Ascites in Pulmonary Function of Patients with Portal Hypertension

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ABSTRACT

Objective: To evaluate the pulmonary function of patients having portal hypertension with altered volume of ascites.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Department of Pulmonology, Faisalabad Medical University, Faisalabad and Abwa Hospital / Research centre Faisalabad from July, 2019 to December, 2019.

Materials and Methods: Fifteen patients with portal hypertension and ascites underwent pulmonary function tests, consisting of spirometry and arterial blood gases, before and after reducing the volume of ascites. The parameters analyzed were: forced vital capacity (FVC); expiratory reserve in the first second (FEV 1); expiratory flow between 25 and 75% of FVC (FEF25-75%); Force expiratory volume 6(FEV6); FEV_1 ratio/ FVC; PEF, arterial oxygen pressure (PaO_2), carbon dioxide arterial pressure ($PaCO_2$) and oxygen saturation (SaO_2).

Results: There was a significant improvement in the lung volumes analyzed after decreasing ascites with diuretic treatment associated or not with paracentesis.

Conclusion: We conclude that in patients with portal hypertension and ascites, there is a decrease in lung volumes in relation to the predicted values, with significant improvement after a decrease in ascites. Likewise, we observed an increase in PaO_2 and SaO_2.

Key Words: Ascites, Portal hypertension, Pulmonary function tests, Compensated cirrhosis, Hypoxemia

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INTRODUCTION

Liver cirrhosis is the main cause of portal hypertension and ascites, which in turn is the main complication found in cirrhotic patients after approximately ten years of diagnosis of compensated cirrhosis, affecting 50% of patients [1-3].

Several changes can be detected by pulmonary function tests in patients with chronic liver disease, especially in those with cirrhosis. These changes, which together characterize the "hepatopulmonary syndrome", cause hypoxemia and occur in one third of patients with cirrhosis [4]. Inadequate oxygenation in patients with cirrhosis is caused by several pathophysiological mechanisms, such as inadequate vascular tone, pulmonary vasodilation, altered ventilation-perfusion ratio (V/Q), increased arteriovenous shunts and changes in the diffusion-perfusion ratio [5-9].

In addition to the changes already expected in cirrhotics, when ascites occurs, we can observe restrictive and obstructive changes in pulmonary function tests with decreased lung volumes &hypoxemia, that improve after reducing ascites[10-14].

The increase in volume and intra-abdominal pressure resulting from ascites leads to a decrease in lung expansion, with consequent hypoventilation, especially in the lung bases. Along with the interstitial edema present in cirrhotic patients, there may be alveolar collapse and micro atelectasis that may explain the spirometric and gasometric changes found. Therefore, ascites, especially when high in volume, impairs the pulmonary function of patients with portal hypertension of different etiologies in a variable way, especially when associated with cirrhosis [15]. This work aims to evaluate and quantify the influence of reduction in the volume of ascetic fluid on the pulmonary function of patients with portal hypertension.

MATERIALS AND METHODS

We analyzed lung function using spirometry and measurement of arterial gases in adult patients, of both sexes, diagnosed with portal hypertension and ascites, admitted to the Department of Pulmonology, Faisalabad Medical University, Faisalabad and Abwa Hospital /

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Resarch centre Faisalabad for the period from 1st July, 2019 to 31st December, 2019. All participants included after being properly informed about proposed treatment and having agreed to the spirometry and arterial blood gas tests.

Exclusion Criteria: Those having previous cardiac and pulmonary diseases, hemodynamic instability, neoplasms, renal failure with serum creatinine >3.5mg/dl, gastrointestinal hemorrhage, encephalopathy, bacterial peritonitis and difficulty in collaborating with the spirometric examination. Smokers were included only when they had no clinical or radiological symptoms or signs of previous pulmonary involvement.

Chest radiographs were found to be within normal limits, with a decrease in lung expansibility as a consequence of the large abdominal volume presented by the patients. The cirrhotic patients classified according to the Child-Pugh criteria for establishing severity of the disease Pic 1.

The patients had moderate to severe ascites, which was characterized by data from the physical and ultrasound examination: high-volume ascites, by simple inspection of the abdomen; ascites with increased abdominal wall tension, as evidenced by palpation; ascites which, due to its proportion, caused respiratory distress to the patient, especially when in the supine position; and ultrasound showing massive ascites.

All patients underwent a pulmonary function study before starting treatment for ascites. The clinical treatment consisted of a prescription for rest, a diet with 2.0 g of salt and diuretics. The diuretic used was spironolactone, associated or not with furosemide. The patients were not submitted to pulmonary physiotherapy. Therapeutic paracentesis was indicated in patients who presented ascites with signs and symptoms of abdominal and respiratory discomfort or in patients who were not responding satisfactorily to clinical treatment with diuretics (continuous weight loss of about 500 g / day).

An average of 6.5 liters of ascitic fluid was removed per patient, with parenteral replacement of a plasma unit (300 ml) for every liters of ascitic fluid drained. After paracentesis, patients were submitted to spirometry, performed the day after the procedure. The spirometric tests were performed at the Pulmonology Department of DHQ Hospital Faisalabad with devices:MIR spirolabIII version 3.1.

The technique used to perform the exam and the parameters obtained and analyzed are in accordance with American Thoracic Society(ATS). The parameters analyzed were: FVC (forced vital capacity); FEV 1 (expiratory volume in the first second); FEF 25-75% (forced expiratory flow between 25 and 75% of FVC); force expiratory volume 6(FEV6), peak expiratory flow (PEF) and FEV 1 / FVC ratio. The slow vital capacity curve (VCC) evaluated lung volumes and capacities and the predicted values adopted were those of Crapo[11]. The volume-time curve (forced spirometry) was performed according to the acceptance and reproducibility criteria of curves recommended by the American Thoracic Society, and the best of three acceptable curves, of eight performed, was chosen. The predicted values were those of Wang WT [12]. Patients undergoing arterial blood gas analysis were analyzed for their arterial oxygen pressure (PaO_2), arterial carbon dioxide pressure ($PaCO_2$) and arterial oxygen saturation (SaO_2). The results of the variables found were analyzed by the Student's t test for paired data. Statistically significant differences were considered when $p<0.050$(5%).

RESULTS

We analyzed 15 patients with portal hypertension and ascites, 9(60%) were male and 6(40%)were females, with ages ranging from 31 to 67 years and mean of 51 ± 9.5 years old. A higher prevalence of patients with diagnosis of liver cirrhosis was observed in 33.33% cases. Portal hypertension associated with hepatitis B or C virus, had a prevalence of 60% (Table-1). Ten patients had a history of Hepatitis C (67%) and 5patients were smokers (33.3%).

Parameter	A	B	C
Albumin, g/dl	>3.5	3.0-3.5	<3.0
Bilirubin, umol/dl	>25	25-40	<40
Bilirubin, mg/dl	>2	2-3	<3
(s above normal)	>4	2-3	<3
Prothrombin level, % Ascites	none	mild controlled	Moderate refractory
Encephalopathy (grade)	0 none	I-II minimal	III-IV advanced

Figure No.1: Child Pugh Score

Table No.1: Distribution according to the frequency of etiological diagnosis of patient

Diagnosis	Number of patient	%age
Cirrhosis with hep c	5	33.33%
Cirrhosis with hep b	2	13.33%
Alcoholism	1	6.66%
Hep b with hep c	2	13.33%
Hepb with alcoholism	1	6.66%
Cryptogenic	1	6.66%
Hep c with alcoholism	2	13.33%
Portal vein thrombosis with hep-c	1	6.33%
Total	15	100%

According to Child-Pugh criteria, applied to 13 patients, except for patients 1 and 3, with cryptogenic cirrhosis, our group was formed mostly by patients with score B (11 patients / 84.6%), with only 2 patients had a C score (15.4%) and no patient had an A score.

Twelve patients underwent therapeutic paracentesis, with removal of 6.5 liters of ascitic fluid and an average loss of 6.9 kg of weight. Three patients showed an excellent response to clinical treatment, with a significant decrease in abdominal volume, with an average loss of 6.4 kg of weight, and were then referred to a new spirometry without undergoing therapeutic paracentesis. The spirometric diagnoses found in the patients analyzed are shown in Table-2.

Table No.2: Spirometry Results Obtained Pre & Post Paracentesis and Clinical Treatment of Ascities Patients

Sr.no.	Pre-treatment	Post treatment
1	OVDSA	OVDSA
2	OVDSA	NL
3	OVDSA	OVDSA
4	NL	NL
5	MVD	NL
6	MOVD	LOVD
7	LOVD	NL
8	LOVD	NL
9	LOVD	LOVD
10	MVD	MVD
11	RVD	NL
12	MVD	LOVD
13	RVD	NL
14	LOVD	NL
15	NL	NL

OVDSA= Obstructive ventilatory disorder of small airway, LOVD= mild obstructive ventilatory disorder, RVD= restrictive ventilatory disorder, MOVD= moderate obstructive ventilatory disorder, MVD= mixed ventilatory disorder, NL= normal.

Our patients, before paracentesis and / or clinical treatment of ascites, presented FVC results below the expected average measurements and obtained a significant improvement in this parameter after treatment. FEV1 values were also reduced before ascites treatment and improved after paracentesis and / or clinical treatment. The FEV 1 ratio / FVC showed no statistically significant difference after treatment. The FEF values 25-75% before paracentesis and / or clinical treatment of ascites were also reduced in relation to the predicted average.

Although we observed an increase after treatment, it was not statistically significant. We can observe that there was an improvement in the FEV6 and PEF after reduction of ascites, with statistical significance. The results in Table 3 briefly demonstrate all the main variables analyzed by us and their degree of significance for the study in question.

Six patients underwent arterial blood gas analysis. Before paracentesis, the mean values found in these patients were: PaO 2 = 68 ± 17mmHg; PaCO 2 = 32 ± 17mmHg; and SaO 2 = 92 ± 6%. After paracentesis, the means were: PaO 2 = 76 ± 17mmHg; PaCO 2 = 29 ± 5mmHg and SaO 2 = 94 ± 4%.

The increase in values of PaO2 and SaO2 showed statistical significance (Table 3).

Table No.3: Comparison of spirometric variables and air gases pre and post paracentesis and clinical treatment of ascities

Variables	Pre-paracentesis	Post paracentesis	Significance (p)
FVC(L)	2,67±0,67	3,13±0,83	*0,002
FVC(%)	82,40±17,00	97,53±12,51	*0,001
FEV1(L)	2,10±0,53	2,45±0,61	*0,001
FEV1(%)	78,33±19,59	93,80±16,74	*<0,001
FEV/FVC (%)	78,07±10,02	78,40±7,58	0,727
FEF 25/75(L/S)	2,12±1,00	2,35±0,85	0,127
FEF 25-75 (%)	75,40±38,94	83,87±33,43	0,170
FEV6(L)	0,73±0,34	1,0±0,50	*0,019
PEF(L/S)	73,27±40,60	100,00±37,42	*0,033
PaO2 (mmHg)	68,25±16,63	75,84±17,01	*0.027
PaCO2 (mmHg)	31,95±7,89	28,70±4,59	0,217
SaO2(%)	91,71±5,99	94,32±4,18	*0,032

FEV=forced expiratory volume FVC=forced vital capacity FEF=Forced expiratory flow PaO2=partial pressure of oxygen $PaCO_2$=partial pressure of carbon dioxide SaO2=oxygen saturation PEF=peak expiratory flow FEV6 =forced expiratory flow in 6 seconds.

DISCUSSION

According to other studies [4-9], the pulmonary changes found in cirrhotic patients are closely related to the degree of impaired liver function. This data is important for the interpretation of the results of our work, since our patients were mostly cirrhotic (60%) with a moderate to advanced degree of disease (Child-Pugh B or C in 86.66% of the cases -13 patients), and may present pulmonary manifestations resulting from their underlying disease, in addition to those caused by increased intra-abdominal pressure as a consequence of ascites. We observed a higher prevalence of obstructive ventilatory disorder (eight patients-53.32%), and in the literature the reports point to a higher prevalence of restrictive ventilatory disorder [12].

As in our work, Zampiet al[13] reported the presence of obstructive ventilatory disorder and concluded that this finding could be related to the degree of hepatic impairment of the patients analyzed. In patients with more advanced liver disease, there would be greater pulmonary interstitial edema and, therefore, greater involvement of the alveoli and bronchioles, causing early closure of the airways on expiration and obstructive disorders.

According to Ramalingam et al [14], the effects of ascites on the respiratory system are probably mediated by the hydrostatic pressure exerted on the diaphragm and the

severity of the damage caused by gas exchange is closely related to the decrease in lung volumes that occurs in these circumstances. We were unable to establish a relationship between smoking and obstructive ventilatory disorder, as only three patients, out of eight with an obstructive pattern, were smokers.

We believe, like other authors, that decrease in intra-abdominal pressure due to reduced volume of ascites, was responsible for the improvement [14,15]. Some studies found hypoxemia in ascitic patients before treatment and reported a significant increase in PaO_2 after diuretic therapy. Possibly the use of diuretics, according to the authors, reduced pulmonary interstitial edema, leading to a more favorable ventilation / perfusion ratio.

A study conducted by Yigitet al [16] documented the presence of a restrictive pattern, with increased in FEV6 and PEF in the pulmonary functional assessment, in cirrhotic patients with and without ascites. They found a decrease in the parameters analyzed when measuring respiratory muscle strength in patients with and without ascites, indicating less effectiveness of the rib cage muscles, which could contribute to the functional changes found. In most of reviewed studies, it was observed, like us, a decrease in FVC, FEV 1, FEV, in addition to PEF before, and significant increases after paracentesis[17-20].

We observed that several patients had a normal spirometric examination after clinical treatment with diuretics, or after paracentesis, showing an evident improvement in respiratory parameters by decreasing the volume of ascites. The FEV 1 / FVC ratio did not show significant differences before and after treatment, which shows that the increases in FEV 1 were proportional to the FVC increases, being very close to the 80% expected for the relationship. The decrease in FEV 1 and FVC with maintenance of the predicted values for the FEV 1 / FVC ratio is found in restrictive pulmonary disorders, which may therefore be associated with the observed obstructive disorders. The small decrease in FEF25-75% found before treatment may be associated with bronchiolar involvement and pulmonary compression with early closure of the small airways, which can occur in patients with liver disease with ascites. The FEV6 and PEF was significantly reduced in our study before the treatment of ascites with significant improvement after its treatment, in agreement with the reviewed studies [21].

In the present study, we found mild hypoxemia in our patients with improvement after treatment. SaO_2 also improved after reducing ascites, but we did not see the same when assessing $PaCO_2$. Probably the improvement in lung volumes, with a consequent improvement in pulmonary ventilation, contributed to better oxygenation. As all patients used diuretics during the study, this may have contributed to an improvement in PaO_2.

CONCLUSION

Reduced ascites volume significantly improves pulmonary ventilation and therapeutic paracentesis seems to be a treatment alternative for rapid relief of symptoms of dyspnea and abdominal discomfort, or for cases in which therapy diuretics is not entirely satisfactory. We concluded that in patients with portal hypertension and ascites, there is a decrease in lung volumes in relation to the predicted values, with significant improvement after a decrease in ascites.

Author's Contribution:

Concept & Design of Study:	Muhammad Mahboob Alam
Drafting:	Umar Usman, Umair Ahmad
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Revisiting Critically:	Muhammad Mahboob Alam, Umar Usman
Final Approval of version:	Muhammad Mahboob Alam

Conflict of Interest: The study has no conflict of interest to declare by any author.

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