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Hepatopulmonary Syndrome in Egyptian Patients with HCV-Related Chronic Liver Disease

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Abstract

Background and Aim: Hepatopulmonary syndrome (HPS) is defined as the presence of liver disease in association with intrapulmonary vascular dilatation and arterial hypoxemia. This work aimed at evaluation of hepatopulmonary syndrome in Egyptian patients with HCV-related chronic liver disease. **Patients and Methods:** This cross-sectional study included sixty patients with HCV-related chronic liver disease who underwent complete clinical evaluation, laboratory investigations, abdominal ultrasonography, plain chest x-ray, arterial blood gas analysis to assess partial pressure of arterial oxygen (PaO_2), partial pressure of arterial carbon dioxide ($PaCO_2$) and alveolar-arterial oxygen gradient ($A\text{-}aDO_2$) in addition to pulmonary function tests. **Results:** The prevalence of HPS was 55% (33 out of the 60 patients). Thirteen cases of them were in Child B and 20 cases in Child C group. There was a highly significant difference between Child A & C and between Child B & C classes as regards PaO_2.There was highly significant difference between the three Child classes as regards spirometry pattern, where 40% of Child C patients showed mild restrictive pattern. There was highly significant difference between positive HPS and negative HPS patients as regards PaO_2, $A\text{-}aDO_2$, VC (L), FVC (L), FEV-1(L/sec), and FEF25-75% (L/sec).There was highly significant positive correlation between A-aDO2 and each of age, INR and portal vein diameter. There was highly significant negative correlation between A-aDO2 and each of serum albumin, PaO_2, VC, FVC, FEV-1 and FEF 25-75%. A cutoff level ≥ 18.4 mmHg for A-aDO2 could detect positive HPS with a sensitivity of 100%, specificity of 96.3%, PPV of 97.1% and NPV of 100%. **Conclusion:** A cutoff level ≥ 18.4 mmHg for A-aDO2 could detect HPS. There is significant correlation between the severity of chronic liver disease and the presence of HPS.

Keywords: Hepatopulmonary syndrome, Chronic liver disease, HCV.

Introduction

Hepatopulmonary syndrome (HPS) is defined as the presence of liver disease in association with intrapulmonary vascular dilatation and arterial hypoxemia presented with an alveolar-arterial oxygen tension difference ($A\text{-}aDO_2$) more than 15 mmHg or a partial pressure of oxygen (PaO_2) below 80 mmHg[(1,2)].HPS is a complication of liver cirrhosis and is reported also in some patients with non-cirrhotic portal hypertension[(3)].

Currently, the only treatment for HPS is liver transplantation (LT).Survival after LT may be lower in patients with HPS than in those without[4].The strongest predictor of death was a preoperative PaO_2 of 50 mmHg or less[5].However, resolution of HPS may be possible after successful orthotopic LT[1].

Because of the poor outcome without LT, the diagnosis of the HPS associated with a PaO_2 of less than 60 mmHg is considered to be an indication for transplantation, and patients with this syndrome are given a higher priority for transplantation than patients with other disorders[6].

This work aimed at evaluation of hepatopulmonary syndrome in Egyptian patients with HCV-related chronic liver disease.

Patients and Methods

This cross-sectional study was conducted on sixty Egyptian patients with HCV-related chronic liver disease who were presented to Tropical Medicine and Internal Medicine Departments and outpatient clinics at Ain Shams University Hospital, during the period from October 2014 to December 2015.

Patients were divided equally into three groups according to the modified Child-Pugh classification[7]: Child A, Child B and Child C; each group included twenty patients.

Patients with co-infection with hepatitis B, other causes of liver disease, hepatocellular carcinoma, portal, splenic or hepatic vein thrombosis, liver transplantation, as well as those with any associated chest, cardiac or other co-morbid diseases were excluded.

Informed written consent was obtained from each patient prior to inclusion. The study protocol was approved by the Research Ethical Committee of Faculty of Medicine, Ain Shams University according to the ethical guidelines of the 1975 Declaration of Helsinki.

All of the included patients underwent:

(1) A complete history taking and thorough clinical examination.
(2) Laboratory investigations:

- Complete blood count (CBC).
- Liver profile: aspartate aminotransferase (AST), alanine aminotransferase (ALT), total and direct bilirubin, serum albumin, prothrombin time and international normalized ratio (INR).
- Renal profile: blood urea nitrogen (BUN), serum creatinine, sodium and potassium.
- Hepatitis markers: HBs Ag, HBc Ab IgM and IgG and HCV Ab using third generation ELISA.

(3) Abdominal ultrasonography for evaluation of liver size and echogenicity, spleen size, portal vein diameter and presence of ascites.

(4) Plain chest x-ray.

(5) Echocardiography: to detect dilatation of right side of the heart and exclude associated cardiac diseases.

(6) Arterial blood gas analysis: Arterial blood gas tensions were assessed at rest while breathing room air and in the sitting position by radial puncture to give report about:

- Partial pressure of arterial oxygen (PaO_2),
- Arterial oxygen saturation (SaO_2)
- Partial pressure of arterial carbon dioxide ($PaCO_2$),
- Alveolar-arterial oxygen gradient ($A\text{-}aDO_2$).

The $A\text{-}aDO_2$ was calculated by the following equation: $PAO_2 - PaO_2 = (F_IO_2\ [P_{atm} - PH_2O] - [PaCO_2/0.8]) - PaO_2$,

where PAO_2 denotes partial pressure of alveolar oxygen, PaO_2 partial pressure of arterial oxygen, F_IO_2 fraction of inspired oxygen, P_{atm} atmospheric pressure, PH_2O partial pressure of water vapor at body temperature, and $PaCO_2$ partial pressure of arterial carbon dioxide (0.8 corresponds to the standard gas-exchange respiratory ratio at rest)[2].

(7) Pulmonary function tests: dynamic spirometry expiratory airflow was done three times for measurement of the following parameters according to ***Perez***[8]:

- Vital capacity (VC): the volume of air breathed out after the deepest inhalation.
- Forced vital capacity (FVC):the volume of air that can forcibly be blown out after full inspiration, measured in liters.
- Forced expiratory volume in one second (FEV1):the volume that has been exhaled at the end of the first second of forced expiration after full inspiration.

- FEV1% (FEV1/FVC ratio): the ratio of FEV1 to FVC. In healthy adults, this should be approximately 75–80%.
- Forced expiratory flow values (FEF25-75%).

Statistical Analysis

Collected data were coded, tabulated, and statistically analyzed using IBM SPSS statistics (Statistical Package for Social Sciences) software version 22. Descriptive statistics such as minimum and maximum of the range, as well as mean ± SD, were used for quantitative parametric data. Median and inter-quartile ranges were used for quantitative non-parametric data, while number and percentage were used for qualitative data. Inferential analyses were done for quantitative variables using independent t-test in cases of two independent groups with parametric data.

The relationships between the parameters were characterized using the Spearman correlation coefficients. The diagnostic performance was assessed using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy and receiver operating characteristic (ROC) curve.

The P-value was considered as:

P > 0.05: non significant, P < 0.05: significant and P < 0.01: highly significant.

Results

This cross-sectional study included 60 Egyptian patients with HCV-related chronic liver disease.They were divided equally into three groups according to the modified Child-Pugh classification: Child A, Child B and Child C; each group included twenty patients.

We studied the prevalence of hepatopulmonary syndrome (HPS) in each group depending on the widened alveolar-arterial oxygen gradient (A-aDO_2) ≥ 15 mmHg.

Child A group included 20 patients; 16 males (80%) and 4 females (20%). Their mean age was 48.15 ± 4.82 years. All patients in this group were negative for HPS.

Child B group included 20 patients; 12 males (60%) and 8 females (40%). Their mean age was 48.85 ± 5.72 years. Thirteen cases of them (65%) had HPS and seven cases (35%) were non-HPS.

Child C group included 20 patients; 15 males (75%) and 5 females (25%). Their mean age was 50.2 ± 5.33 years. All the twenty cases were having HPS (100%).

Thus, among the studied 60 patients with HCV-related chronic liver disease, 33 patients had hepatopulmonary syndrome (HPS) with a prevalence of 55%.

Table (1) shows comparison between the three groups regarding arterial blood gas results. As regards PaO_2 (mmHg), there was a highly significant difference between Child A&C groups and between Child B&C, but no significant difference between Child A&B groups.

There was a highly significant difference between the three groups as regards A-aDO_2 (mmHg)(P-value < 0.001).

Table (2) shows comparison between the three groups as regards spirometry findings. There was no significant difference between them as regards VC (L), FVC (L), FEV-1 (L/sec), FEF 25-75% (L/sec) and FEV-1 /FVC (%).

Table (3) shows that there was highly significant difference between the three groups as regards spirometry pattern, where 40% of Child C patients showed mild restrictive pattern (P-value = 0.004).

Comparison between positive HPS group (n=33) and negative HPS group (n = 27) was done. Regarding respiratory clinical presentations, cyanosis, dyspnea, orthopnea and platypnea were significantly detected in positive HPS group **(Table 4)**. Patients with positive HPS had significantly higher serum total bilirubin, lower serum albumin and more prolonged INR than those with negative HPS **(Table 5).**

Regarding abdominal ultrasonography, the presence of ascites and its poor medical control was highly significantly detected in positive HPS patients (P-value< 0.001) **(Table 6).**

Table (7) shows comparison between positive HPS and negative HPS groups as regards arterial blood gases findings. There was highly significant difference between the two groups as regard PaO_2 (P- value = 0.002)and A-aDO_2(P-value < 0.001). However, there was no significant difference between them as regards $PaCO_2$ and SaO_2.

Table (1): Comparison between the three Child groups as regards arterial blood gases results.

					ANOVA		Tukey's test		
		Child A	Child B	Child C	F	P-value	A&B	A&C	B&C
PaO_2	Range	86.200-97.800	86.500-96.800	76.700-94.000	14.338	**0.000***	0.953	**0.000***	**0.000***
	Mean± SD	92.935± 3.363	93.275± 2.874	87.770± 4.501					
PCO_2	Range	32.000-42.700	30.200-46.000	27.500-51.300	1.249	0.295	0.899	0.283	0.521
	Mean± SD	38.255± 3.130	37.540± 4.675	35.760± 6.904					
A-a DO_2	Range	6.300-12.800	10.000-40.300	31.800-63.800	65.430	**0.000***	**0.000***	**0.000***	**0.000***
	Mean± SD	9.875± 4.241	26.400± 13.555	49.000± 19.428					
SaO_2	Range	91.800-98.200	90.200-98.100	90.300-96.900	0.843	0.436	0.416	0.908	0.671
	Mean± SD	94.570± 1.892	95.360± 2.242	94.830± 1.714					

PaO_2: partial pressure of arterial oxygen (normal range: 75-100 mmHg), **$PaCO_2$**: partial pressure of arterial carbon dioxide (normal range: 35-45 mmHg), **A-aDO_2**: alveolar-arterial oxygen gradient (normal range = 5-10 mmHg),**SaO_2**: arterial oxygen saturation (normal range= 90-100%). *Highly significant.

Table (2): Comparison between the three Child groups as regards spirometry findings.

					ANOVA		Tukey's test		
		Child A	Child B	Child C	F	P-value	A&B	A&C	B&C
VC	Range	2.650-7.650	2.340-7.780	2.450-6.280	1.817	0.172	0.272	0.203	0.984
	Mean± SD	5.345± 1.448	4.626± 1.739	4.547± 1.120					
FVC	Range	2.430-7.090	2.270-7.260	1.980-5.850	2.175	0.123	0.280	0.124	0.896
	Mean± SD	4.994± 1.344	4.301± 1.658	4.100± 1.232					
FEV-1	Range	2.030-5.710	1.900-5.970	1.640-4.630	2.030	0.141	0.390	0.127	0.788
	Mean± SD	3.984± 1.081	3.509± 1.352	3.272± 0.944					
FEF 25-75%	Range	1.760-4.950	1.180-5.040	1.220-4.110	2.347	0.105	0.258	0.106	0.882
	Mean± SD	3.451± 0.959	2.926± 1.263	2.768± 0.869					
FEV-1/ FVC	Range	0.710-0.840	0.750-0.930	0.760-0.860	1.872	0.163	0.183	0.967	0.281
	Mean± SD	0.795± 0.028	0.813± 0.038	0.797± 0.028					

VC: vital capacity (normal adult range: 3-5 L),**FVC:** forced vital capacity (normal range values male:4.8 , female: 3.7 L),**FEV-1:** forced expiratory volume in one second (values between 80% and 120% of the average value for age and sex are considered normal) ,**FEF25-75%:** Forced expiratory flow (< 65% of predicted value considered abnormal),**FEV-1/FVC** (normal range = 75-80%).

Table (3): Comparison between three Child groups as regards spirometry pattern.

Spirometry		Groups			
		Child A	Child B	Child C	Total
Mild restrictive pattern	N	1	1	8	10
	%	5.00	5.00	40.00	16.67
Within normal	N	19	19	12	50
	%	95.00	95.00	60.00	83.33
Total	N	20	20	20	60
	%	100.00	100.00	100.00	100.00
Chi-square	X^2	11.266			
	P-value	**0.004 ***			

*Highly significant.

Table (4): Comparison between positive HPS and negative HPS patients as regards respiratory clinical presentations.

Clinicalpresentation	Negative HPS (n=27)		Positive HPS (n=33)		Total		Test	
	N	%	N	%	N	%	X^2	P-value
Cyanosis	0	0 %	5	15.155	5	8.33	6.349	**0.012***
Dyspnea	7	25.93	32	96.97	39	65.00	37.828	**<0.001****
Orthopna	2	7.41	25	75.76	27	45.00	31.763	**<0.001****
Platypnea	0	0.00	21	63.64	21	35.00	34.432	**<0.001****

* Significant, **Highly significant.

Table (5): Comparison between positive HPS and negative HPS patients as regards laboratory findings.

	Negative HPS (n=27)			Positive HPS (n=33)			T-test	
	Mean	±	SD	Mean	±	SD	t	P-value
AST (7-37 IU/L)	44.593	±	21.006	51.667	±	30.932	-1.012	0.316
ALT (7-40 IU/L)	42.593	±	28.512	47.576	±	26.794	0.701	0.486
Total bilirubin (0.2-1.2 mg/dL)	2.504	±	1.284	3.415	±	1.880	-2.142	**0.036***
Albumin (3.5-5.3 g/dL)	3.789	±	0.464	2.630	±	0.430	5.908	**< 0.001****
INR	1.350	±	0.127	1.645	±	0.565	-2.664	**0.010****

* Significant, **Highly significant.

Table (6): Comparison between positive HPS and negative HPS patients as regards abdominal ultrasonograghic findings.

	Negative HPS (n = 27)		Positive HPS (n=33)		Test	
	Mean ± SD		Mean ± SD		t	P-value
Liver size	14.514 ± 1.509		14.100 ± 1.765		0.858	0.395
Portal vein diameter	10.352 ± 1.142		10.939 ± 1.478		-1.693	0.096
Splenic size	14.052 ± 2.271		13.541 ± 2.392		0.782	0.438
Ascites	N	%	N	%	X^2	P-value
Negative	23	85.19	7	21.21		
Medically controlled	4	14.81	23	69.70	24.549	< **0.001***
Poor control	0	0.00	3	9.09		

*Highly significant.

Table (7): Comparison between positive HPS and negative HPS groups as regards arterial blood gases findings.

	Negative HPS (n = 27)			Positive HPS (n=33)			T-test	
	Mean	±	SD	Mean	±	SD	t	P-value
PaO_2	93.193	±	3.002	89.800	±	4.783	3.203	**0.002***
$PaCO_2$	37.915	±	3.163	36.588	±	6.341	0.990	0.326
A-aDO_2	9.548	±	4.342	43.021	±	12.257	-11.884	**<0.001***
SaO_2	94.789	±	1.925	95.027	±	2.005	-0.466	0.643

*Highly significant.

Table (8) shows comparison between positive HPS and negative HPS groups as regards spirometry findings. There was significant difference between the two groups as regards VC (L), FVC (L), FEV-1(L/sec) and FEF25-75% (L/sec). However, there was no significant difference between them as regards FEV-1/ FVC (%).

Table (8): Comparison between positive HPS and negative HPS groups as regards spirometry findings.

	Negative HPS (n = 27)			Positive HPS (n=33)			T-test	
	Mean	±	SD	Mean	±	SD	T	P-value
VC	5.432	±	1.452	4.354	±	1.332	2.993	**0.004***
FVC	5.084	±	1.368	3.958	±	1.331	3.222	**0.002****
FEV-1	4.083	±	1.127	3.184	±	1.032	3.220	**0.002****
FEF 25-75%	3.523	±	0.998	2.659	±	0.973	3.383	**< 0.001****
FEV-1/ FVC	0.799	±	0.037	0.804	±	0.028	-0.607	0.546

***** Significant, **Highly significant.

There was no significant difference between positive HPS and negative HPS groups as regards spirometry pattern (P-value = 0.071) **(Table 9)**.

Table (10) shows correlation between A-aDO_2 and other parameters among the studied patients. There was highly significant positive correlation between A-aDO_2 and each of age, INR and portal vein diameter.

There was highly significant negative correlation between A-aDO_2 and each of serum albumin, PaO_2, VC, FVC, FEV-1 and FEF25-75%.

Table (9): Comparison between positive HPS and negative HPS groups as regards spirometry pattern.

Spirometry	Negative HPS (n = 27)		Positive HPS (n=33)		Total	
	N	%	N	%	N	%
Mild restrictive pattern	2	7.41	8	24.24	10	16.67
Within normal	25	92.59	25	75.76	50	83.33
Total	27	100.00	33	100.00	60	100.00
X^2	3.254					
P-value	0.071					

Table (10): Correlation between A-aDO_2 and different studied parameters.

Parameter	A-a DO_2	
	r	P-value
Age	0.669	< **0.001***
AST	0.089	0.501
ALT	-0.178	0.173
Total bilirubin	0.235	0.070
Albumin	-0.753	< **0.001***
INR	0.400	**0.002***
PaO_2	-0.495	< **0.001***
$PaCO_2$	-0.095	0.469
SaO_2	-0.042	0.748
VC	-0.427	< **0.001***
FVC	-0.440	< **0.001***
FEV-1	-0.446	< **0.001***
FEF 25-75%	-0.458	< **0.001***
FEV-1\ FVC	0.031	0.817
Liver size	-0.276	0.057
Portal vein diameter	0.398	< **0.001***
Splenic size	-0.093	0.511

*Highly significant.

Figure (1) shows the diagnostic performance of A-aDO_2 at cutoff value > 18.4mmHg which could differentiate between positive and negative HPS patients. Above this cutoff level, A-aDO_2 can detect HPS with a sensitivity of 100%, specificity of 96.3%, PPV of 97.1% and NPV of 100% with a diagnostic accuracy of 99.7%.(Area under ROC curve, AUC=0.984, 95% Confidence Interval=0.500–1.000).

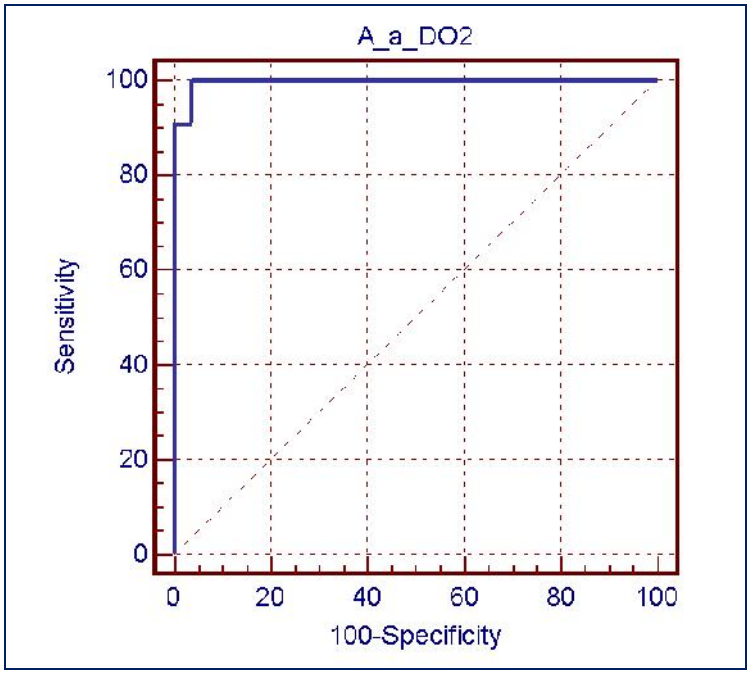

Fig. (1): Receiver operating characteristic (ROC) curve showing the diagnostic performance of A-aDO_2 at cutoff value > 18.4 in detection of hepatopulmonary syndrome (Area under curve, AUC=0.984, 95% Confidence Interval=0.500–1.000).

Discussion

The current study included 60 Egyptian patients with HCV-related chronic liver disease aiming to assess the prevalence of hepatopulmonary syndrome (HPS) in those patients depending on the widened alveolar-arterial oxygen gradient (A-aDO_2) above 15 mmHg.

In our study, HPS was detected in 33 patients out of the studied 60 patients (55%). This agrees with ***Lenci et al.***[9] and ***Arguedas et al.***[10]who found that presence of either intrapulmonary shunts or oxygenation abnormalities are common, occurring in 25–65% of patients awaiting liver transplantation. However, this is not matching with ***Rodriguez-Roisin and Krowka***[2] who reported that data from liver transplantation centers indicated that the prevalence of HPS ranged from 5 to 32%.The reported difference in the prevalence of HPS among different studies is primarily attributed to the use of different cutoff values for the abnormal alveolar–arterial oxygen gradient and partial pressure of oxygen that were used to define gas-exchange abnormalities in addition to different study populations.

In the current study, all Child C patients and 13 of Child B patients were having HPS. However, none of Child A patients had HPS. This is consistent with ***Shalaby et al.***[11] and ***Almohana***[12].However, this was not in agreement with ***Kochar et al.***[13]who reported that there wasn't any association between HPS and the severity of liver disease, as measured by Child–Pugh score.

In the current study, dyspnea was found in 96.97% of HPS group and 25.93% of non-HPS group, with significant difference between both groups. This was close to results of ***Almohana***[12] who reported that all patients with HPS (100%) had dyspnea at rest compared with two patients (9%) from group without HPS ($p < 0.05$). Also, this is comparable to results of ***Shalaby et al.***[11]who reported that in the absence of any cardiopulmonary disease, this symptom could suggest a pulmonary vascular complication of liver disease.

In the current study, platypnea was detected in 63.64% of the HPS group and none of patients in non-HPS group had platypnea, with highly significant difference between both groups. This agrees with ***Alizadeh et al.***[14]who found platypnea in 60% of HPS group and in 0% of non-HPS group with specificity of 100%.

In our study, cyanosis was detected in 15.15% of HPS group and was not detected in the non-HPS group (0%), with significant difference between both groups. This agrees with the study of ***Grace and Angus***[15] who reported that patients with severe HPS may be sufficiently hypoxic to appear cyanosed at rest, and the rare finding of cyanosis and clubbing in a cirrhotic patient is highly specific for the presence of severe HPS. Also, this is matching with the results of ***Hira et al.***[16] who found no cyanosis in the non-HPS group with specificity of 100%, although their results disagreed with us by finding cyanosis in 100% of HPS group in their study.

In our study, all patients in HPS group were having low serum albumin level and there was significant negative correlation between HPS and albumin level. There was significant positive correlation between HPS and PT and INR. These results suggest that HPS development is related to liver synthetic dysfunction. This agrees with ***Alizadeh et al.***[14] who reported strong correlation between HPS and the liver synthetic functions.

In our study, there was significant difference between HPS group and non-HPS as regards total bilirubin level. This is matching with results of ***Shalaby et al.***[11].

The European Respiratory Society Task Force recommended an alveolar-arterial oxygen gradient (A-aDO_2) >15 mmHg for the diagnosis of HPS, whereas partial pressure of arterial oxygen (PaO_2) was used to classify the severity of HPS[1].

In our study, the mean level of PaO_2 was 89.8 mmHg in HPS group and was 93.1 mmHg in non-HPS group. And there was positive correlation between PaO_2 and HPS giving highly significant difference between the 2 groups as regards PaO_2. In our study the mean A-aDO_2 level in HPS group was 43.±12.2 mmHg and was 9.5±4.3 mmHg in non-HPS group and there was a highly significant difference between the two groups as regards A-aDO_2. Also there was significant difference between the three Child classes and A-aDO_2 level.

The cutoff between positive HPS and negative HPS as regard A-aDO2 in our study was 18.4 (mmHg). This means that cases with A-aDO2 greater than 18.4 (mmHg) had positive HPS with sensitivity of 100% and specificity of 96.3%.

This is consistent with the study of ***Grace and Angus***[15] who reported that the most sensitive marker for HPS diagnosis was an increase in the alveolar–arterial oxygen gradient (A-aDO_2) and the recommended cut-off values for the diagnosis of HPS were $PaO_2 \leq 80$mmHg or A-a$DO_2 \geq 15$mmHg.

In ***Abdelazim et al.***[17] study, they utilized $PaO_2 < 70$ mmHg and A-a$DO_2 > 20$ mmHg as the cut off values in detection of HPS.

In the study of ***Alizadeh et al.***[14], PO_2 was less than 70 mmHg in 100% of HPS group and 4.5% of non-HPS group with sensitivity and specificity of 100 % and 95% respectively and was less than 60 mmHg in 30% of HPS and 4.5% of non-HPS with sensitivity and specificity of 30 % and 92% respectively.

Regarding spirometry pattern and Child classification in our study, there was significant difference between the three Child classes as regards spirometry pattern where 40% of Child C patients showed mild restrictive pattern. This is comparable with results of ***Park et al.***[18]who found that 48.3% of their studied patients with chronic liver disease showed pulmonary abnormalities, with high prevalence of diffusion impairment and also restrictive pattern which was noted in < 10% of the total patients and no significant airflow obstructive defect on gas exchange was observed.

Regarding spirometry pattern in HPS patients in our study, 8 patients (24.24%) in HPS group were having mild restrictive spirometry pattern and 25 patients (75.76%) were normal, with no significant difference between the HPS and non-HPS groups. That partially agrees with the study of ***Shalaby et al.***[11] who found that HPS patients tend to have a restrictive pattern of pulmonary function.

Conclusion

A cutoff level ≥ 18.4 mmHg for A-aDO_2 could detect hepatopulmonary syndrome with sensitivity of 100% and specificity of 96.3%. There is significant correlation between the severity of chronic liver disease and both the presence and severity of hepatopulmonary syndrome.

Conflict of interest:

None of the authors have any conflicts of interests and no financial disclosure.

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