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Original Article

Comparison of Pulmonary Function Tests in Asymptomatic Biliary Liver Cirrhosis versus Healthy Individuals

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ABSTRACT

Background: Primary biliary cirrhosis may be accompanied by pulmonary abnormalities, although their frequency and relationship with clinically symptomatic disease remain uncertain. Objective: To compare pulmonary-function parameters in patients with primary biliary cirrhosis and healthy individuals and to assess differences between symptomatic and asymptomatic patients. Methods: This prospective comparative observational study included 26 patients with primary biliary cirrhosis and 19 healthy controls at Lahore General Hospital from January 2021 to January 2023. Nineteen patients were symptomatic and seven were asymptomatic. Spirometry, lung volumes, diffusing capacity for carbon monoxide, ventilation distribution, arterial blood gases, exercise capacity, and right-to-left shunting were assessed. Group means were compared using independent-samples tests, while categorical findings and the relationship between DLCO and exercise capacity were also evaluated. Results: Fourteen patients (53.8%) had at least one abnormal pulmonary-function finding. Abnormalities occurred in 13/19 symptomatic patients (68.4%) and 1/7 asymptomatic patients (14.3%; p=0.026). Mean DLCO was lower in patients than controls (76.1±16.1% vs 88.1±12.1% predicted; mean difference −12.0, 95% CI −20.5 to −3.5; p=0.007). Symptomatic patients had lower DLCO than asymptomatic patients (70.9±14.6% vs 84.5±13.8%; p=0.050). DLCO correlated positively with maximum working capacity (r=0.74). Conclusion: Pulmonary abnormalities, particularly reduced DLCO, were frequent in primary biliary cirrhosis and were more prominent among symptomatic patients. Keywords: Primary biliary cirrhosis; primary biliary cholangitis; pulmonary function tests; diffusing capacity; DLCO; liver disease; exercise capacity.

INTRODUCTION

Primary biliary cirrhosis is a chronic cholestatic liver disease characterized by progressive immune-mediated destruction of the small intrahepatic bile ducts. It predominantly affects middle-aged women and may eventually result in fibrosis, cirrhosis, portal hypertension, and hepatic decompensation. Histopathological findings commonly include portal inflammation, bile duct injury, and granuloma formation, supporting the proposed autoimmune basis of the disease (1,2). Primary biliary cirrhosis may also coexist with extrahepatic autoimmune disorders, including Sjögren syndrome, systemic sclerosis, autoimmune thyroid disease, and other rheumatological conditions (3,4).

Pulmonary complications are well recognized in advanced chronic liver disease. These may arise from ventilation–perfusion mismatch, intrapulmonary vascular dilatation, anatomical right-to-left shunting, pulmonary vascular disease, or alterations in the alveolar–capillary membrane. In patients with primary biliary cirrhosis, respiratory abnormalities may additionally be related to coexisting autoimmune disorders, interstitial pulmonary involvement, airway disease, or granulomatous inflammation.

Pulmonary granulomas and fibrotic changes have been described in selected patients, although their frequency, clinical importance, and relationship with the severity of hepatic disease remain uncertain (5,6).

Previous studies have reported reductions in diffusing capacity for carbon monoxide, abnormalities in lung volumes, airway obstruction, and impaired exercise performance among patients with primary biliary cirrhosis. However, these findings have not been consistent, and their interpretation has frequently been complicated by smoking, anaemia, asthma, emphysema, Sjögren syndrome, systemic sclerosis, and other coexisting disorders (7). It also remains unclear whether measurable pulmonary dysfunction occurs in patients without overt respiratory symptoms or whether such abnormalities are more frequent among patients with clinically symptomatic liver disease.

Patients with primary biliary cirrhosis may be categorized clinically as asymptomatic or symptomatic according to manifestations such as pruritus, jaundice, xanthoma, xanthelasma, hyperpigmentation, hepatomegaly, and splenomegaly. Although this clinical classification does not replace biochemical or histological staging, it may help identify patients with a greater burden of clinically apparent disease (8,9). Evaluating pulmonary function across these clinical groups may therefore improve understanding of the frequency and pattern of respiratory involvement and help determine whether pulmonary assessment should form part of the broader clinical evaluation of affected patients.

The present study aimed to assess pulmonary-function abnormalities in patients with primary biliary cirrhosis compared with healthy individuals and to examine whether pulmonary-function parameters differed between symptomatic and asymptomatic patients. Particular attention was given to lung volumes, airflow indices, diffusing capacity for carbon monoxide, exercise capacity, arterial oxygenation, and anatomical right-to-left shunting.

MATERIALS AND METHODS

A prospective comparative observational study was conducted in the Department of Medicine, Lahore General Hospital, Lahore, Pakistan, from January 2021 to January 2023. Consecutive patients with a diagnosis of primary biliary cirrhosis who were evaluated or managed by the department during the study period were considered for inclusion. The diagnosis was based on a compatible clinical presentation and laboratory findings and was supported by liver histopathology where biopsy was clinically feasible. Patients in whom the available clinical, biochemical, or histopathological findings did not support the diagnosis were not included in the analysis.

A total of 26 patients with primary biliary cirrhosis were included. Patients were classified as symptomatic when they had one or more clinically apparent manifestations, including pruritus, jaundice, xanthoma, xanthelasma, hyperpigmentation, hepatomegaly, or splenomegaly. Patients without these manifestations were categorized as asymptomatic. On this basis, 19 patients were classified as symptomatic and seven as asymptomatic. Clinical information, duration of disease, smoking status, serum bilirubin, serum alkaline phosphatase, and other available laboratory and histopathological findings were recorded for subsequent comparisons.

A healthy comparison group was selected from individuals participating in an epidemiological assessment. Twenty-eight potentially eligible individuals were approached, of whom 19 agreed to participate. The control group comprised 16 women and three men aged 42–67 years, with a mean age of approximately 56 years. Controls were selected to provide an age- and sex-comparable reference group and underwent the same clinical respiratory assessment and core pulmonary-function testing as the patient group.

All patients and healthy controls were evaluated by the same chest physician to reduce interobserver variability. The assessment included clinical examination, posteroanterior and lateral chest radiography, dynamic spirometry, measurement of lung volumes, and assessment of pulmonary diffusing capacity.

Exercise testing and estimation of anatomical right-to-left shunting were undertaken in the subgroup of patients for whom these measurements were available.

Dynamic spirometry was performed using a Bernstein spirometer. Recorded indices included vital capacity, forced expiratory volume in the first second, the expiratory volume ratio reported as FEV%, and maximum voluntary ventilation. Functional residual capacity was determined using the closed-circuit helium-dilution technique, from which total lung capacity and residual volume were calculated. Pulmonary-function measurements were expressed as percentages of the predicted values appropriate to the participant's demographic characteristics. Obstructive, restrictive, and hyperinflation patterns were classified according to the recorded combinations of expiratory airflow and lung-volume measurements.

Diffusing capacity for carbon monoxide was determined using the single-breath technique and was expressed as a percentage of the predicted value. A value below 70% of the predicted value was classified as reduced in accordance with the threshold applied in the original analysis. Haemoglobin concentration was considered when interpreting reduced diffusing capacity because anaemia may lower the measured value. Ventilation distribution was assessed using a modified single-breath nitrogen test. The phase III alveolar plateau slope was measured and reported relative to the predicted nitrogen concentration gradient. Nitrogen concentration was analysed using an Ohio 700 nitrogen analyser.

Arterial blood gases were measured using standard electrodes with a Radiometer ABL 1 analyser. Anatomical right-to-left shunting was assessed from arterial blood samples obtained before and after 20 minutes of breathing 100% oxygen. A shunt fraction greater than 7.5% of cardiac output was considered increased according to the threshold used in the study.

Exercise capacity was evaluated using an electronically braked bicycle ergometer. Workload was progressively increased in six-minute stages until the participant reached symptom-limited maximal exertion. Maximum working capacity was calculated using the reference procedure applied in the study. A 12-lead electrocardiogram was recorded before and after exercise, and six-lead electrocardiographic monitoring was undertaken during the exercise test.

Keratoconjunctivitis sicca was assessed using the Schirmer test and rose Bengal staining. It was considered present when the Schirmer test result was less than 5 mm over five minutes in association with rose Bengal evidence of corneal or conjunctival epithelial damage. The presence of keratoconjunctivitis sicca was examined in relation to pulmonary-function abnormalities and reduced diffusing capacity. The available findings from the Kveim test, liver histopathology, serum immunoglobulin M, alkaline phosphatase, bilirubin, antimitochondrial antibodies, C1q binding, and alpha-1 antitrypsin phenotyping were also examined in exploratory analyses.

Data were analysed using IBM SPSS Statistics version 22.0. Continuous variables were summarized as mean ± standard deviation, and categorical variables were presented as frequencies and percentages. Student's independent-samples t-test was used to compare continuous pulmonary-function measurements between groups when the assumptions of parametric testing were satisfied. Associations between categorical variables were assessed using the chi-square test, with consideration of the small group sizes when interpreting the results. Linear regression and correlation analysis were used to examine the relationship between diffusing capacity for carbon monoxide and maximum working capacity. Statistical tests were two-sided, and a p-value below 0.05 was considered statistically significant.

The study was conducted after approval from the relevant ethics committee of Ameer-ud-Din Medical College, Lahore. Participant information was handled confidentially, and the study procedures were undertaken in accordance with applicable institutional ethical requirements.

RESULTS

Twenty-six patients with primary biliary cirrhosis and 19 healthy controls were included in the comparative analysis. Among the patients, 19 were classified as symptomatic and seven as asymptomatic. Fourteen of the 26 patients had at least one abnormal pulmonary-function finding, corresponding to an overall prevalence of 53.8%. Abnormal pulmonary-function findings were observed in 13 of 19 symptomatic patients (68.4%) compared with one of seven asymptomatic patients (14.3%; Fisher's exact p=0.026).

Table 1. Pulmonary-Function Parameters in Symptomatic and Asymptomatic Patients With Primary Biliary Cirrhosis

Pulmonary-function parameter, % predicted	Asymptomatic PBC (n=7), mean ± SD	Symptomatic PBC (n=19), mean ± SD	Mean difference (95% CI)	p-value
Total lung capacity	91.9 ± 12.9	100.9 ± 10.0	9.0 (−3.2 to 21.2)	0.130
Vital capacity	91.5 ± 9.7	97.9 ± 10.7	6.4 (−3.2 to 16.0)	0.173
Maximum voluntary ventilation	93.5 ± 14.0	92.1 ± 15.5	−1.4 (−15.3 to 12.5)	0.830
Residual volume	92.5 ± 23.1	106.9 ± 16.5	14.4 (−7.4 to 36.2)	0.167
Expiratory volume ratio	103.1 ± 8.9	93.7 ± 8.0	−9.4 (−18.0 to −0.8)	0.035
Forced expiratory volume in 1 second	98.0 ± 13.5	95.5 ± 13.5	−2.5 (−15.7 to 10.7)	0.682
Phase III nitrogen slope	109.9 ± 52.0	146.9 ± 95.0	37.0 (−24.3 to 98.3)	0.222
Diffusing capacity for carbon monoxide	84.5 ± 13.8	70.9 ± 14.6	−13.6 (−27.2 to 0.0)	0.050

CI: confidence interval; PBC: primary biliary cirrhosis; SD: standard deviation. Mean differences were calculated as symptomatic minus asymptomatic values. P-values were derived using Welch's independent-samples t-test.

Symptomatic patients showed a lower mean expiratory volume ratio than asymptomatic patients, with a between-group mean difference of −9.4 percentage points (95% CI, −18.0 to −0.8; p=0.035). Mean diffusing capacity was also lower in symptomatic patients by 13.6 percentage points, although the confidence interval approached the null value (95% CI, −27.2 to 0.0; p=0.050). Symptomatic patients had numerically higher total lung capacity, residual volume, and phase III nitrogen slope, but these differences were not statistically significant. Vital capacity, forced expiratory volume in 1 second, and maximum voluntary ventilation were broadly comparable between the two patient groups.

Table 2. Pulmonary-Function Parameters in Patients With Primary Biliary Cirrhosis and Healthy Controls

Pulmonary-function parameter, % predicted	All PBC patients (n=26), mean ± SD	Healthy controls (n=19), mean ± SD	Mean difference (95% CI)	p-value
Total lung capacity	97.9 ± 10.8	98.1 ± 9.1	−0.2 (−6.2 to 5.8)	0.947
Vital capacity	96.1 ± 18.3	98.5 ± 8.4	−2.4 (−10.7 to 5.9)	0.559
Maximum voluntary ventilation	93.4 ± 15.1	98.1 ± 14.0	−4.7 (−13.5 to 4.1)	0.289
Residual volume	102.7 ± 19.1	93.8 ± 12.3	8.9 (−0.6 to 18.4)	0.065
Expiratory volume ratio	97.2 ± 10.1	100.3 ± 5.9	−3.1 (−7.9 to 1.7)	0.203
Forced expiratory volume in 1 second	97.1 ± 13.4	102.9 ± 10.2	−5.8 (−12.9 to 1.3)	0.107
Phase III nitrogen slope	139.1 ± 82.2	108.5 ± 7.7	30.6 (−2.7 to 64.0)	0.070
Diffusing capacity for carbon monoxide	76.1 ± 16.1	88.1 ± 12.1	−12.0 (−20.5 to −3.5)	0.007

CI: confidence interval; PBC: primary biliary cirrhosis; SD: standard deviation. Mean differences were calculated as PBC minus control values. P-values were derived using Welch's independent-samples t-test.

Compared with healthy controls, patients with primary biliary cirrhosis had a significantly lower mean diffusing capacity for carbon monoxide. The mean difference was −12.0 percentage points of the predicted value (95% CI, −20.5 to −3.5; p=0.007). Residual volume was numerically higher among patients, with a mean difference of 8.9 percentage points, but the confidence interval included no difference (95% CI, −0.6 to 18.4; p=0.065). The phase III nitrogen slope was also higher among patients, although the comparison did not reach statistical significance (mean difference, 30.6 percentage points; 95% CI, −2.7 to 64.0; p=0.070). No statistically significant differences were found for total lung capacity,

vital capacity, maximum voluntary ventilation, forced expiratory volume in 1 second, or the expiratory volume ratio.

Table 3. Frequency and Pattern of Abnormal Pulmonary-Function Findings in Patients With Primary Biliary Cirrhosis

Pulmonary finding	n/N (%)
Any abnormal pulmonary-function finding	14/26 (53.8)
Abnormal pulmonary-function finding among symptomatic patients	13/19 (68.4)
Abnormal pulmonary-function finding among asymptomatic patients	1/7 (14.3)
Reduced diffusing capacity for carbon monoxide	9/25 (36.0)
Obstructive spirometric pattern	5/26 (19.2)
Hyperinflation	2/26 (7.7)
Restrictive spirometric pattern	1/26 (3.8)
Bronchial asthma among patients with abnormal pulmonary findings	3/14 (21.4)
Pulmonary emphysema among patients with abnormal pulmonary findings	1/14 (7.1)

The denominator for reduced diffusing capacity was 25 because this measurement was unavailable for one patient with emphysema. Categories were not mutually exclusive because some patients had more than one pulmonary-function abnormality.

Reduced diffusing capacity was the most frequent specific abnormality and was documented in nine of the 25 patients with an available measurement (36.0%). All nine patients with reduced diffusing capacity were from the symptomatic group. Four were current smokers, one was a former smoker, and four were nonsmokers. Three patients with reduced diffusing capacity had mild anaemia, although the manuscript indicated that haemoglobin adjustment did not fully account for the reduction.

Five patients demonstrated an obstructive spirometric pattern, including patients with known bronchial asthma or emphysema. Hyperinflation was identified in two patients, while one asymptomatic patient demonstrated a restrictive pattern. Chest radiography showed hyperinflation in the patient with severe emphysema but did not identify corresponding abnormalities in the remaining patients or healthy controls.

Table 4. Individual Pulmonary-Function Profiles of Patients With Abnormal Findings

Clinical group	VC, % predicted	TLC, % predicted	RV, % predicted	Expiratory volume ratio, % predicted	DLCO, % predicted	Pulmonary-function pattern
Asymptomatic	75	75	74	110	73	Restrictive
Symptomatic	83	86	94	87	62	Reduced DLCO
Symptomatic	111	119	137	90	55	Reduced DLCO; hyperinflation
Symptomatic with asthma	87	88	91	78	84	Obstructive
Symptomatic with asthma	102	125	183	93	77	Hyperinflation
Symptomatic	104	160	112	95	67	Reduced DLCO
Symptomatic	87	94	109	96	50	Reduced DLCO
Symptomatic	108	106	103	79	64	Reduced DLCO; obstructive
Symptomatic	87	102	134	81	58	Reduced DLCO; obstructive
Symptomatic	100	93	75	96	65	Reduced DLCO
Symptomatic with emphysema	58	107	198	43	—	Obstructive
Symptomatic with asthma	83	93	112	83	83	Obstructive
Symptomatic	97	102	115	93	65	Reduced DLCO
Symptomatic	113	110	104	97	69	Reduced DLCO

DLCO: diffusing capacity for carbon monoxide; RV: residual volume; TLC: total lung capacity; VC: vital capacity. All measurements are expressed as percentages of predicted values.

Among the 14 patients with abnormal pulmonary-function findings, 13 were symptomatic and one was asymptomatic. Nine had a DLCO below 70% of the predicted value, with measured values ranging from

50% to 69%. Five showed an obstructive pattern, two showed hyperinflation, and one demonstrated a restrictive pattern. Some patients had overlapping abnormalities, particularly reduced DLCO combined with obstruction or hyperinflation.

In the subgroup that underwent both exercise testing and measurement of diffusing capacity, DLCO showed a strong positive relationship with maximum working capacity (r=0.74), indicating that lower gas-transfer capacity was associated with lower exercise performance. Abnormal pulmonary-function findings were identified in four of six patients with keratoconjunctivitis sicca; however, no statistically significant association was found between keratoconjunctivitis sicca and either overall pulmonary dysfunction or reduced DLCO.

Arterial oxygen tension was within the normal range in all assessed patients except the patient with severe emphysema, whose arterial oxygen tension was 7.3 kPa. An increased anatomical right-to-left shunt was identified in eight of 19 evaluated patients (42.1%). The mean shunt fraction was 6.5%, with values ranging from 3.9% to 10.0%. No statistically significant relationships were observed between increased shunt or abnormal pulmonary function and serum bilirubin, serum alkaline phosphatase, serum immunoglobulin M, liver-biopsy stage, alpha-1 antitrypsin phenotype, C1q binding, or antimitochondrial-antibody findings.

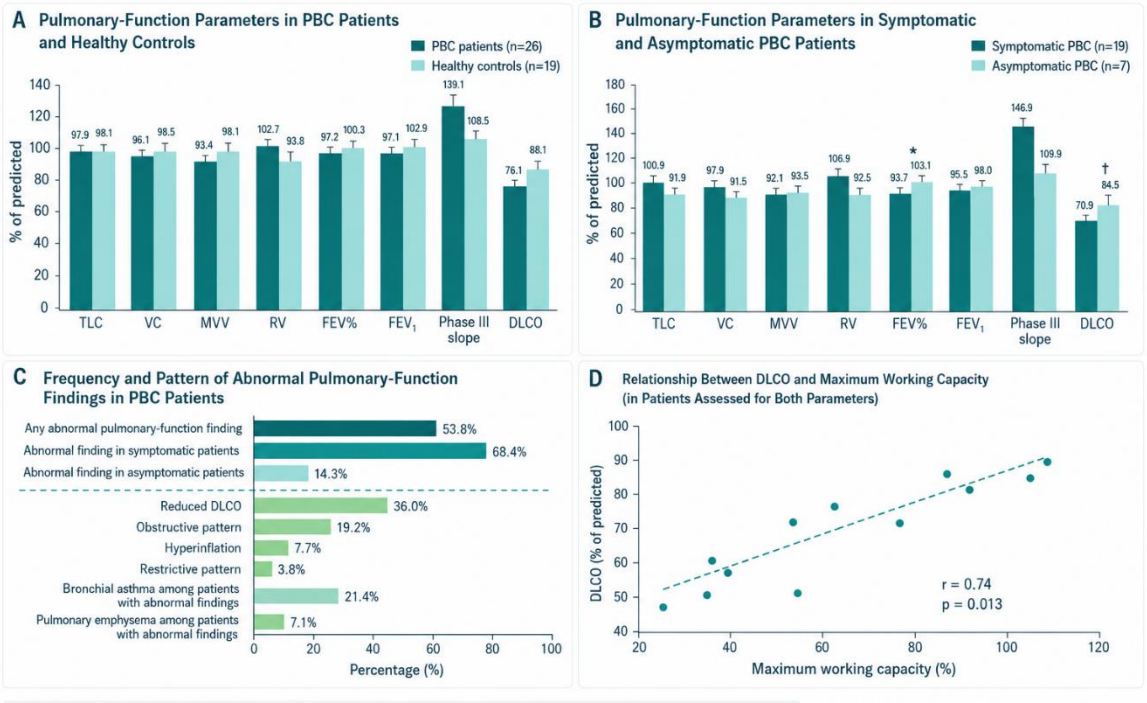

Figure 1. The multipanel figure shows that patients with primary biliary cirrhosis had lower DLCO than healthy controls, while symptomatic patients demonstrated more pronounced reductions in DLCO and expiratory volume ratio than asymptomatic patients. Overall, 53.8% of patients had abnormal pulmonary-function findings, rising to 68.4% among symptomatic patients, with reduced DLCO being the most common abnormality. DLCO also showed a strong positive correlation with maximum working capacity (r=0.74, p=0.013), indicating that impaired gas transfer was associated with poorer exercise performance.

DISCUSSION

The principal finding of this study was that pulmonary-function abnormalities were common among patients with primary biliary cirrhosis, particularly those with clinically symptomatic disease. More than half of the patients had at least one abnormal pulmonary-function finding, and the frequency was substantially higher among symptomatic than asymptomatic patients. Reduced diffusing capacity for carbon monoxide was the most frequent specific abnormality and represented the clearest difference between patients with primary biliary cirrhosis and healthy controls. Symptomatic patients also demonstrated a lower expiratory volume ratio and numerically higher residual volume and phase III

nitrogen slope, suggesting that abnormalities in gas transfer and ventilation distribution may occur even when conventional spirometric indices remain relatively preserved.

The mean diffusing capacity was approximately 12 percentage points lower in patients with primary biliary cirrhosis than in healthy controls. This finding supports previous reports that impaired gas transfer may occur as an extrahepatic manifestation of chronic cholestatic liver disease. Pulmonary abnormalities in primary biliary disease may arise through several mechanisms, including intrapulmonary vascular dilatation, ventilation–perfusion mismatch, thickening of the alveolar–capillary interface, interstitial involvement, autoimmune-mediated pulmonary injury, and coexisting connective-tissue disease. Pulmonary vascular complications and hepatopulmonary syndrome have also been described among patients with chronic liver disease, particularly those undergoing assessment for transplantation (6,9,10).

Reduced diffusing capacity was more prominent among symptomatic patients than asymptomatic patients. The mean DLCO was 70.9% of the predicted value in symptomatic patients compared with 84.5% in asymptomatic patients, corresponding to a mean difference of 13.6 percentage points. Although this comparison was at the threshold of statistical significance, the magnitude and direction of the difference were clinically relevant. These findings suggest that pulmonary gas-transfer impairment may be more frequent in patients with a greater clinical burden of primary biliary disease. Nevertheless, symptomatic status represented a broad clinical classification rather than a validated measure of hepatic severity, and no significant associations were identified between pulmonary dysfunction and liver-biopsy stage, serum bilirubin, alkaline phosphatase, immunoglobulin M, or antimitochondrial-antibody findings. Pulmonary impairment therefore could not be attributed solely to the severity of hepatic disease.

The lower expiratory volume ratio among symptomatic patients and the presence of obstructive patterns in several individuals indicated that airway dysfunction contributed to the overall pulmonary abnormalities. However, some of these findings occurred in patients with known bronchial asthma or emphysema. Coexisting pulmonary disease must therefore be considered when interpreting obstruction, hyperinflation, and reduced diffusing capacity in patients with primary biliary cirrhosis. The absence of major differences in vital capacity, total lung capacity, maximum voluntary ventilation, and forced expiratory volume in 1 second suggested that conventional spirometry alone may not adequately identify pulmonary involvement in this population.

The phase III nitrogen slope was numerically higher among patients than healthy controls and among symptomatic than asymptomatic patients. Although these differences were not statistically significant, the observed pattern may indicate uneven ventilation distribution or early small-airway dysfunction. The substantial variability in this measure and the small sample limited the precision of the comparison. Larger studies using standardized contemporary pulmonary-function protocols would be required to determine whether abnormalities in ventilation distribution represent a reproducible feature of primary biliary disease.

A strong positive relationship was observed between diffusing capacity and maximum working capacity. Patients with lower DLCO tended to have lower exercise capacity, indicating that impaired pulmonary gas transfer may have functional consequences even when resting spirometric measurements are relatively preserved. Exercise limitation in chronic liver disease is multifactorial and may reflect reduced pulmonary diffusion, anaemia, skeletal-muscle deconditioning, cardiovascular impairment, malnutrition, or advanced hepatic dysfunction. Consequently, the observed correlation should not be interpreted as evidence that reduced DLCO alone caused diminished exercise performance.

An increased anatomical right-to-left shunt was identified in 42.1% of the assessed patients. Intrapulmonary vascular dilatation and anatomical shunting are recognized mechanisms of impaired oxygenation in chronic liver disease and hepatopulmonary syndrome (6,10). Most participants

nevertheless maintained normal resting arterial oxygen tension, indicating that physiological shunting may occur before clinically evident hypoxaemia. The patient with severe emphysema had reduced arterial oxygen tension, emphasizing the need to distinguish liver-related pulmonary vascular abnormalities from pre-existing respiratory disease.

Primary biliary disease frequently overlaps with systemic autoimmune disorders, particularly Sjögren syndrome and systemic sclerosis (1,7,11). In the present study, four of six patients with keratoconjunctivitis sicca had abnormal pulmonary-function findings, but no statistically significant association was observed between keratoconjunctivitis sicca and reduced DLCO. The small number of affected patients restricted statistical power, and the absence of a significant association did not exclude a clinically meaningful relationship. Future studies should systematically evaluate autoimmune overlap syndromes because these conditions may independently cause airway disease, interstitial lung disease, and impaired diffusing capacity.

Some similarities may exist between pulmonary abnormalities observed in primary biliary disease and those reported in granulomatous or fibrotic pulmonary disorders. However, the present study did not include high-resolution computed tomography, bronchoscopy, pulmonary histopathology, or other direct assessments of granulomatous lung involvement. The findings therefore should not be interpreted as evidence that the pulmonary abnormalities were caused by sarcoidosis or pulmonary granulomas. The observed physiological patterns provide a rationale for further investigation rather than confirmation of a shared pathological mechanism.

The study had several strengths. Patients underwent a broad physiological assessment that included spirometry, lung volumes, diffusing capacity, ventilation distribution, arterial blood gases, exercise capacity, and estimation of anatomical shunting. The use of a healthy comparison group and evaluation by the same chest physician improved comparability across participants. The study also examined symptomatic and asymptomatic patients separately, allowing exploration of pulmonary abnormalities across clinically different presentations.

Several limitations should be considered. The study was conducted at a single centre and included a small sample, resulting in imprecise estimates and limited ability to perform adjusted analyses. Smoking, anaemia, asthma, emphysema, autoimmune overlap disorders, and disease duration may have influenced pulmonary-function measurements. The healthy controls were not recruited through formal individual matching, and not all physiological tests were available for every participant. The study used symptom-based classification rather than a validated biochemical or prognostic severity score. Contemporary lower-limit-of-normal criteria, standardized quality-control information, haemoglobin-corrected DLCO values, and detailed imaging findings were not available. The cross-sectional comparison also prevented evaluation of temporal changes or determination of whether pulmonary abnormalities progressed with liver disease.

Despite these limitations, the findings indicate that pulmonary abnormalities, particularly reduced diffusing capacity, may occur in patients with primary biliary cirrhosis and may be more frequent among those with clinically symptomatic disease. Pulmonary-function assessment, including measurement of DLCO, may therefore provide clinically useful information in patients who report respiratory limitation, have advanced clinical manifestations, or are being considered for major surgery or liver transplantation. Larger prospective studies should evaluate these findings using standardized pulmonary-function criteria, contemporary liver-disease severity measures, systematic assessment of autoimmune overlap disorders, and multivariable adjustment for pulmonary confounders.

CONCLUSION

Pulmonary-function abnormalities were frequent among patients with primary biliary cirrhosis and were more common in symptomatic than asymptomatic patients. Reduced diffusing capacity for carbon

monoxide was the predominant abnormality and was significantly lower in patients than in healthy controls, while lower DLCO was also associated with reduced exercise capacity. These findings support the clinical relevance of pulmonary assessment in primary biliary cirrhosis, particularly among patients with symptomatic disease, while acknowledging that smoking, anaemia, and coexisting respiratory or autoimmune disorders may contribute to the observed abnormalities.

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