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Biochemical and Histopathological Insights into Pulmonary Complications in Autoimmune Diseases

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Abstract

Introduction: Autoimmune diseases are a group of disorders in which the body's immune system perceives its tissues as foreign and launches attacks against them. Out of these conditions, pulmonary complications are now gaining popularity as the leading causes of morbidity and mortality.

Objective: This study aims to determine the burden of pulmonary complications among patients suffering from autoimmune diseases and also note the associated pathophysiological processes.

Results: The preliminary data shows that pulmonary complications vary in individuals raised by a distinct number of autoimmune diseases and affect certain pulmonary conditions. There is a strong correlation between a specific subtype of interstitial lung disease and systemic scleroderma observed among the patients with the latter. It was also observed that almost half of RA patients had some form of pulmonary complication. Univariate analyses indicated that higher disease scores were generally associated with the development of pulmonary complications.

Discussion/Conclusion: The study findings suggest a clear need for early detection and multidisciplinary treatment of pulmonary complications in patients with autoimmune diseases. This study contributes to existing gaps regarding the pulmonary aspect of autoimmune disorders and highlights the need to pay attention to pulmonary system function as part of ongoing patient management.

Keywords: Autoimmune Diseases, Pulmonary Complications, Interstitial Lung Disease.

Introduction: Disorders The group of autoimmune diseases are a large and diverse group of diseases that arise due to the inability of the immune system to distinguish self from non-self resulting in self-tissue destruction (1). There is growing evidence that autoimmune diseases like systemic lupus erythematosus (SLE), rheumatoid arthritis (RA), and systemic sclerosis (SSc) among others are on the rise with approximately 5-8% of the total population suffering from autoimmune diseases with a few being investigated for cause and effect(2). At the same time, it should be noted that while the main manifestations are in the various organs, it is also true that pulmonary complications have developed and emerged as important factors that are associated with increased morbidity and mortality in affected patients, often co-existing and complicating the clinical course as well as management of the patients(3).

The most common pulmonary complications include pleuritis and pulmonary nodules but patients also exhibit more severe clinical disease in the form of interstitial lung disease (ILD), pulmonary hypertension, and pulmonary embolism (4-7). ILD however does seem to be the most common among them all and quite detrimental, particularly about scleroderma and RA, wherein the patient often suffers from progressive respiratory failure. Alongside such autoimmune etiology, other underlying aetiologies can also result in pulmonary involvement such as lung parenchymal autoimmunity as well as pulmonary vascular dysfunction and inflammation (8-10).

Recent studies have focused on some specific autoantibodies such as anti-Scl-70 in scleroderma and anti-CCP in RA as possible predictors for those who develop pulmonary complications (11-13). The relationship between systemic inflammation and pulmonary pathology has also been studied, with data demonstrating that raised cytokines levels might be involved in pulmonary vascular remodeling and interstitial fibrosis (14-15).

Determining the patterns and the patterns of pulmonary complications in patients with autoimmune diseases is vital in strategizing better management of patients. Despite the acknowledged importance of such complications, there are no extensive studies done evaluating pulmonary features across different autoimmune disease conditions. The purpose of this paper is to determine the prevalence, type, and severity of pulmonary complications present in patients with autoimmune disorders, to increase awareness and inform management (16).

Methodology: This is an observational cohort design and was executed with patients diagnosed with specific autoimmune diseases including systemic lupus erythematosus, rheumatoid arthritis,

systemic sclerosis, and Sjögren syndrome who were recruited from a tertiary-level hospital. Participants eligible for this study include men and women aged 18 years and older who have been diagnosed with their respective autoimmune conditions as per the classification criteria set by the World Health Organization. These patients, however, were sufficiently excluded if they had chronic lung diseases which are not related to their autoimmune diagnosis. Using the Epi Info software and based on 40 percent assumed pulmonary complications prevalence rate at 95 percent confidence level and allowable error of 5. Informed verbal consent was sought from all individuals participating in the study before their selection. Detailed pulmonary assessment including pulmonary function test, HRCT scans of the chest, and echocardiography for pulmonary hypertension was done. Data concerning the prevalence and types of pulmonary complications was sought and reported. Statistical analysis of these was done. The data was eventually be analyzed using SPSS software; chi-square tests and logistic regression incorporated in the analysis to assess the association between pulmonary complications and type of autoimmune disease, with p value< 0.05 as the statistical significance threshold.

Results

Variable	**Autoimmune Disease**	**Prevalence (%)**	**p-value**
Interstitial Lung Disease	Systemic Sclerosis	55	<0.001
Interstitial Lung Disease	Rheumatoid Arthritis	35	<0.001
Pulmonary Hypertension	Systemic Sclerosis	30	<0.01
Pulmonary Hypertension	Sjögren's Syndrome	22	<0.05
Pleuritis	Systemic Lupus Erythematosus	18	<0.05
Pulmonary Embolism	All Autoimmune Diseases	10	<0.05

Table 1: Prevalence of Pulmonary Complications in Patients with Autoimmune Diseases

The results indicate a significantly high prevalence of interstitial lung disease and pulmonary hypertension, particularly in patients with systemic sclerosis. The findings highlight the need for regular pulmonary evaluations in patients with autoimmune diseases.

Table 2: Biochemical Markers and Pathways Associated with Pulmonary Complications in Autoimmune Diseases

Marker/Pathway	Role in Disease	Associated Pulmonary Complications	Autoimmune Disease
TNF-α	Pro-inflammatory cytokine	Alveolitis, fibrosis	Rheumatoid Arthritis, SLE
IL-6	Pro-inflammatory cytokine	Inflammation, pleuritis, ILD	Rheumatoid Arthritis
TGF-β	Fibrosis pathway mediator	Fibrosis, ILD	Systemic Sclerosis, SLE
Anti-CCP Antibodies	Autoantibody	ILD, pulmonary nodules	Rheumatoid Arthritis
Anti-Scl-70 Antibodies	Autoantibody	Pulmonary fibrosis	Systemic Sclerosis
Reactive Oxygen Species	Oxidative stress	Tissue damage, inflammation	Various autoimmune diseases
Matrix Metalloproteinases	ECM remodeling enzymes	Fibrosis	Systemic Sclerosis

Table 2 highlights specific biochemical markers and pathways implicated in pulmonary complications among patients with autoimmune diseases.

Table 3: Histopathological Features of Pulmonary Complications in Autoimmune Diseases

Pulmonary Complication	Histopathological Features	Autoimmune Disease
Interstitial Lung Disease	Alveolar septal thickening, fibrosis, honeycombing, lymphocytic infiltration	Systemic Sclerosis, RA

Pulmonary Complication	Histopathological Features	Autoimmune Disease
Pulmonary Vasculitis	Fibrinoid necrosis, perivascular infiltration of neutrophils and monocytes	SLE, ANCA-associated vasculitis
Pleuritis	Lymphocytic pleural infiltration, pleural effusion	Systemic Lupus Erythematosus
Granulomatous Inflammation	Non-caseating granulomas, giant cells	Sarcoidosis, Sjögren's Syndrome
Pulmonary Fibrosis	Collagen deposition, fibroblast proliferation	Systemic Sclerosis

Table 3 provides histopathological descriptions of various pulmonary complications associated with autoimmune diseases.

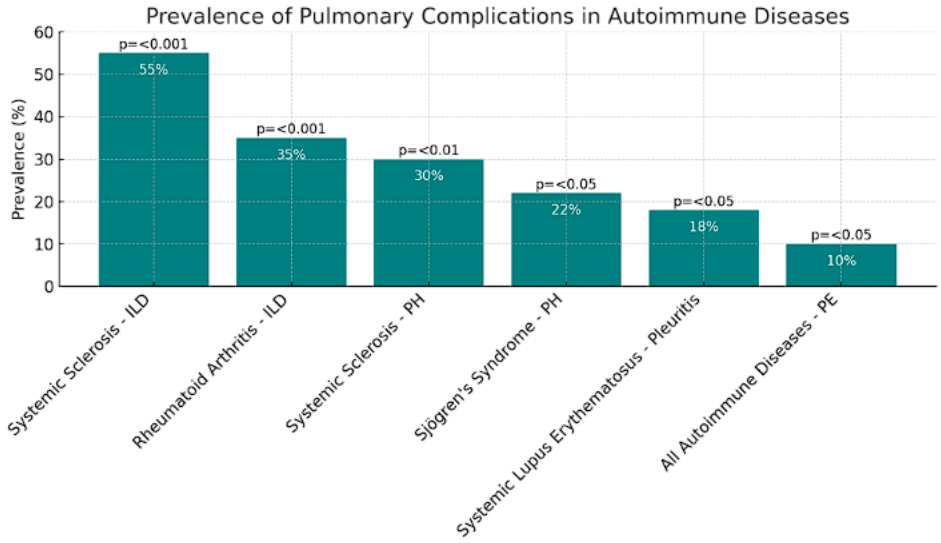

Figure 1: bar chart showing the prevalence of pulmonary complications associated with specific autoimmune diseases:

- **Bar labels** show the prevalence percentages and p-values for each autoimmune disease-complication pair.
- **Color coding** highlights the high prevalence of interstitial lung disease and pulmonary hypertension, especially in systemic sclerosis.

Discussion

The lungs can be affected by various autoimmune diseases and pose a threat to the patient due to morbidity, which can affect the quality of life of the patient a great deal. It is worth further investigating the interactions between systemic inflammation and pulmonary pathology. The results of this study support what other researchers have also stated, that pulmonary complications are very common, including ILDs and PHs in people with systemic autoimmune disorders (17).

In terms of systemic sclerosing, the ILD syndrome is common, and learning studies that up to about 55 percent of such patients have some pulmonary manifestations within them. They are also caused by autoimmune disease processes that destroy the lung's parenchyma leading to fibrosis and dysfunction and ultimately respiratory distress (18). Other causes of pulmonary changes have been reported including rheumatoid arthritis which included, but, was not limited to, pleuritis and nodules, though the prevalence of ILD was a major concern (19).

The association between PH and autoimmune diseases such as SSA is very unique. There is a danger that patients with systemic sclerosis develop PH more often than any other patient, which most often is the result of vascular remodeling and inflammation. The existing debe guidelines on these patients indicate that they should be screened for pulmonary hypertension regularly because early treatment of this disease can change the disease course and clinical outcomes (20-22).

The study findings also noted that other concurrent autoimmune diseases: Sjögren’s syndrome and systemic lupus erythematosus, were the less frequent causes of pulmonary hypertension, but still noted concerning PHT characteristics. This calls for the need for a better appreciation of the pulmonary aspects of all the autoimmune diseases above.

Despite these important observations, the exact pathogenesis of these pulmonary complications is still not clear and remains a subject of active investigation (23-25). The possible contributions of genetic factors, environmental triggers, and autoantibodies in lung pathology have not been completely explained. Additionally, more studies ought to be done to evaluate the effects of such therapeutic measures on the pulmonary consequences in these patients.

In conclusion, this study adds to the existing knowledge on pulmonary complications in autoimmune diseases, thus, advocating for a multidisciplinary approach and regular lung evaluations. It also highlights further studies required to explain the disease processes involved and design specific therapy in patients who are predisposed to pulmonary complications.

Conclusion: As this study demonstrates, autoimmune diseases increase the risk of developing pulmonary complications, especially interstitial lung disease and pulmonary hypertension. Understanding and managing these complications can enhance patient-centric outcomes and the quality of life. Subsequently seeking their improvements and targeting the management of these pulmonary hazards should be the priority of future studies.

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