

CORRELATION BETWEEN COUGH CHARACTERISTICS AND HRCT PATTERNS IN FIBROTIC INTERSTITIAL LUNG DISEASES AND PULMONARY SARCOIDOSIS

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ABSTRACT

Introduction: Fibrotic interstitial lung diseases and pulmonary sarcoidosis represent diffuse pulmonary disorders with different pathological and radiological patterns. High-resolution computed tomography (HRCT) plays a central role in the evaluation of these conditions, enabling detailed assessment of parenchymal abnormalities and their distribution.

Aim: To evaluate the relationship between cough characteristics and HRCT imaging patterns in patients with fibrotic interstitial lung diseases (ILDs) (UIP and NSIP) and pulmonary sarcoidosis.

Materials and Methods: This retrospective observational study included 120 patients with diffuse lung diseases diagnosed at the University Clinic for Pulmonology and Allergology in Skopje, including 70 patients with fibrotic interstitial lung diseases (UIP and NSIP) and 50 patients with pulmonary sarcoidosis. Clinical data were collected using a structured questionnaire assessing cough characteristics, dyspnea, smoking status, and the MRC dyspnea scale. HRCT scans were analyzed for the presence of reticular changes, ground-glass opacities, micronodules, consolidations, hypoattenuation, traction bronchiectasis, fibrosis, and honeycombing. Associations between clinical variables and HRCT findings were analyzed using the χ^2 test and Fisher's exact test. P values between 0.05 and 0.10 were interpreted as indicating a statistical trend.

Results: Cough was present in approximately 80% of patients with fibrotic interstitial lung diseases. Productive cough was more common in UIP, whereas dry cough was more frequent in NSIP. In pulmonary sarcoidosis, dry cough predominated in the early stages, while productive or mixed cough was more common in advanced disease. Dyspnea was highly prevalent in fibrotic ILDs and increased with sarcoidosis stage. HRCT patterns characterized by perilymphatic and peribronchovascular micronodules were more frequently observed in patients without cough, whereas fibrotic abnormalities, including traction bronchiectasis and pulmonary fibrosis, were associated with more pronounced respiratory symptoms.

Conclusion: Respiratory symptoms in diffuse lung diseases show significant associations with HRCT imaging patterns. Fibrotic interstitial lung diseases are associated with more pronounced cough and dyspnea, whereas pulmonary sarcoidosis demonstrates milder symptoms in the early stages and increasing respiratory impairment in advanced stages.

Keywords: high-resolution computed tomography, interstitial lung disease, usual interstitial pneumonia, nonspecific interstitial pneumonia, pulmonary sarcoidosis, cough

INTRODUCTION

Diffuse lung diseases represent a heterogeneous group of pulmonary disorders characterized by varying degrees of inflammation and fibrosis affecting the pulmonary interstitium and parenchyma [1,2]. Among these conditions, fibrotic interstitial lung diseases such as usual interstitial pneumonia (UIP) and nonspecific interstitial pneumonia (NSIP), as well as granulomatous disorders such as pulmonary sarcoidosis, are important causes of diffuse pulmonary involvement [3–5].

High-resolution computed tomography (HRCT) has become a key imaging modality for the evaluation of diffuse lung diseases, enabling detailed visualization of parenchymal abnormalities such as reticular changes, ground-glass opacities, micronodules, consolidations, and fibrotic changes [6,7]. HRCT findings often reflect the underlying pathological processes and provide valuable information regarding disease activity and severity [8].

Fibrotic interstitial lung diseases are characterized by progressive architectural distortion of the pulmonary parenchyma, often accompanied by traction bronchiectasis, honeycombing, and subpleural reticulation [9]. In contrast, pulmonary sarcoidosis typically demonstrates a perilymphatic distribution of micronodules and peribronchovascular involvement, reflecting granulomatous inflammation along the lymphatic pathways [10–12].

Respiratory symptoms such as cough and dyspnea are among the most common clinical manifestations in diffuse lung diseases [13]. Chronic cough is particularly frequent in fibrotic interstitial lung diseases and may occur in up to 80% of patients with idiopathic pulmonary fibrosis, significantly impairing the quality of life [14,15]. In contrast, pulmonary sarcoidosis often presents with milder respiratory symptoms, particularly in the early stages of the disease [16].

Understanding the relationship between the clinical symptoms and HRCT imaging patterns may provide important insights into disease behavior and progression and contribute to improved clinical assessment of diffuse lung diseases [17,18].

AIM OF THE STUDY

To evaluate the relationship between cough characteristics and HRCT imaging patterns in patients with fibrotic interstitial lung diseases (UIP and NSIP) and pulmonary sarcoidosis.

MATERIALS AND METHODS

Study Design and Population

This retrospective observational study included patients with diffuse lung diseases who underwent high-resolution computed tomography of the lungs using a 128-slice Philips In-cisive CT scanner at the University Clinic for Pulmonology and Allergology in Skopje between January 2022 and January 2024. The scans were obtained using a thin-section protocol with a slice thickness of 1 mm and reconstructed with a high-spatial-frequency algorithm optimized for evaluation of the pulmonary parenchyma. Scans were performed during full inspiration in the supine position. A total of 120 patients were included in the analysis, including 70 patients with fibrotic interstitial lung diseases (usual interstitial pneumonia and nonspecific interstitial pneumonia) and 50 patients with pulmonary sarcoidosis. The diagnosis was established based on the clinical evaluation, radiological findings, and multidisciplinary discussion involving pulmonologists and radiologists.

The patients were consecutively included throughout the study period in order to minimize potential selection bias and ensure a representative sample of patients with diffuse lung disease.

Inclusion and Exclusion Criteria

Patients aged 18 to 85 years with clinical symptoms and radiological findings suggestive of interstitial lung disease who underwent HRCT examination were considered for inclusion in the study. All participants voluntarily agreed to participate, completed the questionnaire, and provided written informed consent in accordance with the ethical standards for data collection and scientific research.

Patients with pulmonary embolism, malignant diseases, congestive cardiac conditions, hemodynamic instability, tuberculosis, HIV infection, or chronic obstructive pulmonary disease (COPD) were excluded from the study. Pregnant women were also excluded.

HRCT examinations were reviewed by a radiologist experienced in thoracic radiology.

Collection of Clinical Data

The clinical data were collected using a structured 20-question questionnaire assessing demographic characteristics, smoking status (current smoker, former smoker, or non-smoker), and respiratory symptoms such as dyspnea and cough. Dyspnea severity was assessed using the Modified Medical Research Council (MRC) dyspnea scale. Although multiple clinical variables were recorded, this study primarily focused on cough and its characteristics, including cough intensity (mild, moderate, or severe) and cough type (dry, productive, or mixed). The patients with pulmonary sarcoidosis were classified according to the Scadding radiographic stage based on chest radiography (stages I–IV). Although HRCT provides a more detailed assessment of the pulmonary involvement, universally accepted HRCT-based staging system for sarcoidosis has not yet been established; therefore, HRCT was used primarily for the characterization of the parenchymal abnormalities and their distribution.

HRCT Protocol and Image Analysis

All patients underwent HRCT of the lungs using a standard 1 mm thin-section protocol optimized for pulmonary parenchymal evaluation. HRCT scans were systematically analyzed for the presence of reticular changes, ground-glass opacities, micronodular abnormalities measuring 1–3 mm, masses and consolidations, hypoattenuation, traction bronchiectasis, and fibrotic changes including honeycombing. The distribution of radiological abnormalities was assessed according to the pulmonary zones (upper, middle, and lower) and anatomical localization, including central, peribronchovascular, peripheral, and subpleural distribution.

Ethical Approval

The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Ss. Cyril and Methodius University in Skopje

(approval number 03-1208/8). All participants provided written informed consent, and the study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 25.0, IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic, clinical, and radiological characteristics of the study population. Categorical variables were presented as frequencies and percentages.

Associations between the clinical variables and HRCT findings were evaluated using the χ^2 test for categorical data. In cases where the expected frequency in any cell of the contingency table was less than five, Fisher's exact test was applied to ensure statistical validity. Subgroup analyses were performed to assess the relationship between HRCT patterns and the presence of cough, as well as the association between clinical characteristics and sarcoidosis stage. All statistical tests were two-sided, and a p-value < 0.05 was considered statistically significant. P values between 0.05 and 0.10 were interpreted as indicating a statistical trend.

RESULTS

A total of 120 patients with diffuse lung diseases were included in the study, including 70 patients with fibrotic interstitial lung diseases, comprising usual interstitial pneumonia (UIP) and nonspecific interstitial pneumonia (NSIP), and 50 patients with pulmonary sarcoidosis.

Baseline sociodemographic characteristics of patients with NSIP and UIP are presented in Table 1. Patients with UIP were significantly older than those with NSIP (66.8 ± 8.5 vs. 61.1 ± 14.1 years, $p = 0.039$), whereas no statistically significant differences were observed regarding sex distribution or place of residence.

Cough was one of the most common respiratory symptoms in the studied population. Among patients with fibrotic interstitial lung diseases, cough was present in approximately 80% of cases. Although the overall prevalence

of cough was similar between UIP and NSIP, differences in cough characteristics were observed. Severe cough was registered exclusively in patients with UIP, whereas patients with NSIP more frequently reported mild cough. Produc-

tive cough tended to be more frequent in UIP, whereas dry cough was more common in NSIP; however, these differences did not reach statistical significance but demonstrated a trend toward difference between groups ($p=0.06$) (Table 2).

Table 1. Sociodemographic Characteristics of Patients with NSIP and UIP

Groups	NSIP	UIP	p-level
Female n (%)	19 (63.33)	22 (55)	$\chi^2=0.5$, $p=0.48$
Male n (%)	11 (36.67)	18 (45)	
Age/years mean $\pm$ SD	61.1 $\pm$ 14.1	66.8 $\pm$ 8.5	$t=2.11$, $*p=0.039$
Min-max	31-84	52-82	
Urban residence	30 (100)	37 (92.5)	$\chi^2=2.3$, $p=0.12$
Rural residence	0	3 (7.5)	

NSIP – nonspecific interstitial pneumonia

UIP – usual interstitial pneumonia

χ^2 (Chi-square test); t (Student's t-test)

*sig $p<0.05$

Table 2. Cough Characteristics in Patients with NSIP and UIP

Groups	NSIP n (%)	UIP n (%)	p-level
Cough present	24 (80)	32 (80)	
No cough	6 (20)	8 (20)	
Mild cough	9 (37.5)	5 (15.62)	Fisher's exact test $p=0.069$
Moderate cough	15 (62.5)	23 (71.88)	
Severe cough	0	4 (12.5)	
Dry cough	8 (33.33)	4 (12.5)	$\chi^2=3.5$, $p=0.06$
Productive cough	16 (66.67)	28 (87.5)	

NSIP – nonspecific interstitial pneumonia

UIP – usual interstitial pneumonia

χ^2 (Chi-square test)

Table 3. Dyspnea in Patients with NSIP and UIP

Dyspnea	NSIP n (%)	UIP n (%)	p-level
Yes	29 (96.67)	34 (91.89)	$\chi^2=0.7$, $p=0.41$
No	1 (3.33)	3 (8.11)	

NSIP – nonspecific interstitial pneumonia

UIP – usual interstitial pneumonia

χ^2 (Chi-square test)

Dyspnea was highly prevalent among patients with fibrotic interstitial lung diseases, occurring in more than 90% of cases. No statistically significant difference in dyspnea prevalence was observed between UIP and NSIP (Table 3).

Analysis of HRCT findings demonstrated differences between UIP and NSIP in the distribution of hypoattenuation changes. Hypoattenuation in the lower lung zones, particularly with peripheral and subpleural distribution, was more frequently present in UIP than in NSIP, whereas no statistically significant difference was identified in peribronchovascular distribution, although a borderline trend toward higher prevalence in UIP was observed ($p=0.088$) (Table 4).

Additional HRCT findings in patients with NSIP and UIP demonstrated that diffuse ground-glass opacities were more frequently present in NSIP, whereas honeycombing was significantly more frequent in UIP. Other findings, including

residual ground-glass opacities, traction bronchiectasis, bronchiolectasis/bronchiocele, irregular interlobular septal thickening, consolidations, nodular opacities, emphysema, and lymphadenopathy, showed no statistically significant differences, although a borderline trend toward higher prevalence of consolidations in NSIP was observed ($p=0.08$) (Table 5).

Additional analysis revealed an association between the smoking status and the distribution of reticular abnormalities on HRCT. Peripheral and subpleural reticular changes in both upper/middle and lower lung zones were significantly more frequent in smokers than in non-smokers, suggesting a possible relationship between smoking and the development and distribution of fibrotic interstitial abnormalities. In contrast, no statistically significant association was identified for peribronchovascular reticular abnormalities (Table 6).

Table 4. HRCT Hypoattenuation Findings in Upper and Middle Zones – NSIP and UIP

Variable	NSIP n (%)	UIP n (%)	p-level
Peripheral and subpleural hypoattenuation – yes	14 (46.67)	31 (77.5)	$\chi^2=7.1$, ** $p=0.0077$
Peripheral and subpleural hypoattenuation – no	16 (53.33)	9 (22.5)	
Peribronchovascular hypoattenuation – yes	5 (16.67)	14 (35)	$\chi^2=2.9$, $p=0.088$
Peribronchovascular hypoattenuation – no	25 (83.33)	26 (65)	

NSIP – nonspecific interstitial pneumonia

UIP – usual interstitial pneumonia

χ^2 (Chi-square test)

**sig $p<0.01$

Table 5. Additional Findings

Variable	NSIP n (%)	UIP n (%)	p-level
Diffuse ground-glass opacity – yes	8 (26.67)	1 (2.5)	$\chi^2=8.9$, ** $p=0.0028$
Residual ground-glass opacity – yes	18 (60)	29 (72.5)	$\chi^2=1.2$, $p=0.27$
Traction bronchiectasis – yes	27 (90)	30 (75)	$\chi^2=2.6$, $p=0.11$
Honeycombing – yes	3 (10)	22 (55)	$\chi^2=15.1$, *** $p=0.0001$
Bronchiolectasis/bronchiocele – yes	19 (63.33)	18 (45)	$\chi^2=2.3$, $p=0.13$
Irregular septal thickening – yes	6 (20)	7 (17.5)	$\chi^2=0.07$, $p=0.79$
Consolidations – yes	4 (13.33)	1 (2.5)	$\chi^2=3.03$, $p=0.08$
Nodular changes – yes	5 (16.67)	2 (5)	$\chi^2=2.6$, $p=0.11$
Emphysema – yes	7 (23.33)	4 (10)	$\chi^2=2.3$, $p=0.13$
Lymphadenopathy – yes	25 (83.33)	33 (82.5)	$\chi^2=0.008$, $p=0.93$

NSIP – nonspecific interstitial pneumonia

UIP – usual interstitial pneumonia

χ^2 (Chi-square test)

sig $p<0.01$; *sig $p<0.0001$

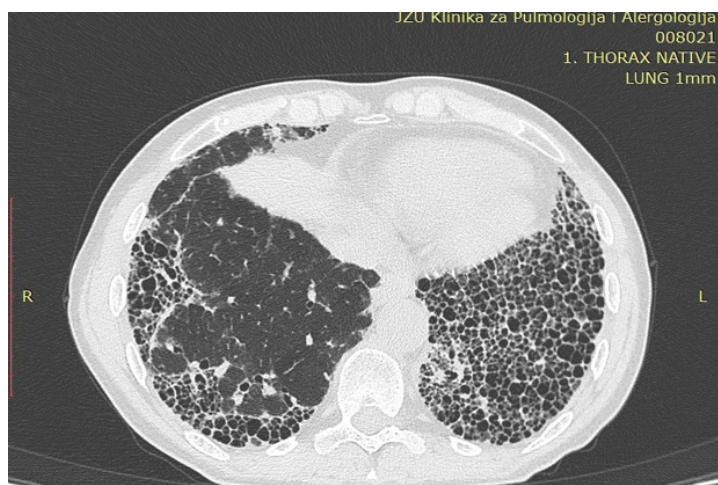


Figure 1. *UIP pattern with honeycombing in bilateral posterobasal regions.*

Figure 2. *UIP pattern in idiopathic pulmonary fibrosis, with honeycombing in middle and distal bilateral subpleural regions and prominent traction bronchiectasis in the right lung.*

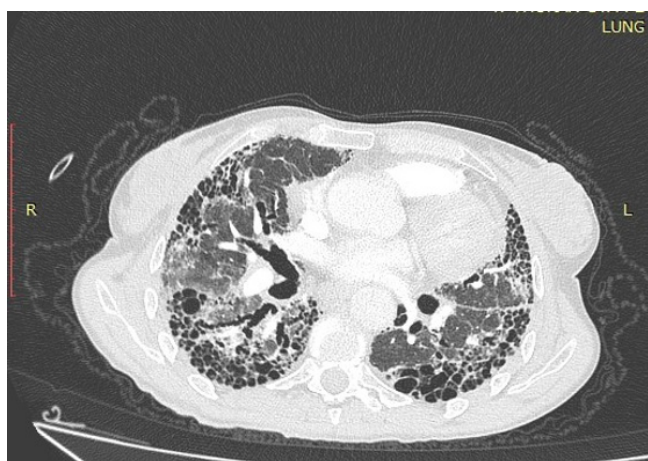
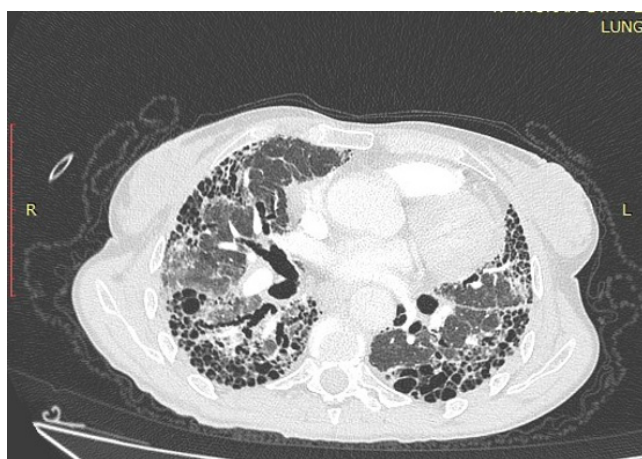


Figure 3. *NSIP pattern in primary systemic disease with extensive ground-glass attenuation, interstitial reticulations, and bronchiolectasis.*

Table 6. *Distribution of Reticular Changes According to Smoking Status*

HRCT finding	Smokers n (%)	Non-smokers n (%)	p-level
Upper and middle zones – peripheral and subpleural – yes	10 (33.33)	0	**p=0.0034
Upper and middle zones – peribronchovascular – yes	8 (26.67)	2 (10)	p=0.28
Lower zones – peripheral and subpleural – yes	12 (40)	0	**p=0.0014
Lower zones – peribronchovascular – yes	8 (26.67)	4 (20)	p=0.74

p (Fisher's exact test)

**sig p<0.01

Among patients with pulmonary sarcoidosis included in the analysis of micronodular changes, 40 patients reported cough, whereas 10 patients had no cough. Micronodular abnormalities measuring 1–3 mm were also analyzed according to the presence or absence of cough. Peribronchovascular micronodules in the upper and middle lung zones were significantly more frequent in patients without cough. Similarly, perilymphatic peribronchovascular micronodules in the upper and middle zones were more commonly observed in patients without cough. No significant association was identified for micronodular abnormalities in the lower zones or for subpleural perilymphatic micronodules (Table 7).

Micronodular abnormalities larger than 3 mm demonstrated a less consistent relationship with cough. No significant differences were identified in the upper and middle lung zones for either peripheral/subpleural or peribronchovascular distribution. However, in the lower lung zones, peripheral and subpleural micronodular abnormalities larger than 3 mm were more frequent in patients without cough (Table 8).

In patients with pulmonary sarcoidosis, cough was also frequently present; however, its

characteristics varied according to disease stage. Dry cough predominated in the early stages of sarcoidosis, whereas productive or mixed cough was more frequent in advanced stages. Dyspnea showed a significant association with disease stage, with increasing prevalence and severity in more advanced stages.

Finally, the analysis of the clinical characteristics according to sarcoidosis stage demonstrated a clear association between disease progression and respiratory impairment. Patients with advanced sarcoidosis stages had a higher prevalence of dyspnea, more severe cough symptoms, and higher MRC dyspnea scores. Advanced sarcoidosis stages were also associated with fibrotic HRCT abnormalities, including traction bronchiectasis and pulmonary fibrosis. Cough intensity demonstrated a borderline trend toward the difference between stages (p=0.06), with severe cough occurring in advanced stages (Table 9).

DISCUSSION

This study evaluated the relationship between the respiratory symptoms and HRCT im-

Table 7. *Distribution of 1–3 mm Micronodular Changes in Patients With Cough (n=40) and Without Cough (n=10)*

Variable	Cough n (%)	No cough n (%)	p-level
Upper/middle zones – centrilobular – yes	0	0	
Upper/middle zones – peribronchovascular – yes	4 (10)	4 (40)	*p=0.041
Lower zones – peribronchovascular – yes	2 (5)	2 (20)	p=0.17
Perilymphatic upper/middle zones – peribronchovascular – yes	14 (35)	10 (100)	*p=0.044
Perilymphatic upper/middle zones – subpleural – yes	10 (25)	0	p=0.18
Perilymphatic lower zones – peribronchovascular – yes	2 (5)	0	p=1.0
Perilymphatic lower zones – subpleural – yes	2 (5)	0	p=1.0

p (Fisher's exact test)

*sig p<0.05

Table 8. *Distribution of Micronodular Changes Larger Than 3 mm in Patients With and Without Cough*

Variable	Cough n (%)	No cough n (%)	p-level
Upper/middle zones – peripheral and subpleural – yes	8 (20)	2 (20)	p=1.0
Upper/middle zones – peribronchovascular – yes	8 (20)	2 (20)	p=1.0
Lower zones – peripheral and subpleural – yes	0	2 (20)	*p=0.037
Lower zones – peribronchovascular – yes	2 (5)	0	p=1.0

p (Fisher's exact test)

*sig p<0.05

Table 9. *Clinical Characteristics According to Sarcoidosis Stage*

Variable	Stage 1 n=4 (%)	Stage 2 n=24 (%)	Stage 3 n=4 (%)	Stage 4 n=18 (%)	p-level
Cough present	4 (100)	18 (75)	4 (100)	14 (77.78)	p=0.71
Mild cough	4 (100)	10 (55.56)	2 (50)	4 (28.57)	p=0.06
Moderate cough	0	8 (44.44)	2 (50)	6 (42.86)	
Severe cough	0	0	0	4 (28.57)	
Dry cough	4 (100)	16 (88.89)	2 (50)	6 (42.86)	*p=0.032
Productive cough	0	2 (11.11)	0	4 (28.57)	
Mixed cough	0	0	0	2 (14.29)	
Whitish sputum	0	0	2 (50)	2 (14.29)	
Dyspnea – yes	2 (50)	14 (58.33)	4 (100)	18 (100)	**p=0.003
MRC 0	4 (100)	10 (41.67)	0	0	***p=0.000
MRC 1	0	12 (50)	4 (100)	6 (33.33)	
MRC 2	0	2 (8.33)	0	6 (33.33)	
MRC 3	0	0	0	4 (22.22)	
MRC 4	0	0	0	2 (11.11)	

*sig p<0.05, **sig p<0.01, ***sig p<0.0001

aging patterns in patients with fibrotic interstitial lung diseases (UIP and NSIP) and pulmonary sarcoidosis. The results suggest that cough and dyspnea are common clinical manifestations in diffuse lung diseases; however, their severity varies according to the underlying radiological pattern and disease stage. Among patients with fibrotic interstitial lung diseases, cough was highly prevalent and tended to be more severe and productive, particularly in those with UIP. In contrast, patients with pulmonary sarcoidosis more frequently presented with dry cough in the early stages of disease, whereas productive cough and increased dyspnea were observed in advanced stages associated with fibrotic remodeling. Additionally, HRCT patterns such as perilymphatic and peribronchovascular micronodules were more frequently present in patients without cough, whereas fibrotic abnormalities, including traction bronchiectasis and pulmonary

fibrosis, were associated with more pronounced respiratory symptoms.

Cough is widely recognized as one of the most common symptoms in fibrotic interstitial lung diseases, particularly idiopathic pulmonary fibrosis. Previous studies have demonstrated that cough occurs in approximately 70–85% of patients with fibrotic ILD and is often associated with significant impairment in the quality of life [14,15]. In our cohort, cough was present in approximately 80% of patients with fibrotic ILD, which is consistent with previously published data.

Although cough prevalence was similar between UIP and NSIP in our study, differences in its characteristics were observed. Patients with UIP demonstrated a tendency toward more severe and productive cough, whereas patients with NSIP more frequently reported mild or dry cough. These findings may be ex-

plained by the underlying pathophysiology of UIP, which is characterized by pronounced architectural distortion of the pulmonary parenchyma, traction bronchiectasis, and peripheral fibrosis. Structural distortion of the airways and retention of secretions may increase cough reflex sensitivity and contribute to more severe cough symptoms [9].

In contrast, NSIP typically demonstrates a more homogeneous inflammatory or fibrotic pattern with less pronounced structural distortion compared with UIP [1,19]. This difference may explain the milder cough symptoms in patients with NSIP. Previous studies have also shown that patients with NSIP generally have a more favorable clinical course and better prognosis compared with those with UIP [19].

Pulmonary sarcoidosis represents a fundamentally different pathological process characterized by noncaseating granulomatous inflammation affecting the lymphatic interstitium of the lungs [20]. Typical HRCT findings include perilymphatic micronodules distributed along the bronchovascular structures, interlobular septa, and subpleural regions [10–12]. In many cases, particularly in the early stages of disease, sarcoidosis may present with relatively mild respiratory symptoms [16].

In this study, cough characteristics in sarcoidosis varied according to disease stage. Dry cough predominated in the early stages, whereas productive or mixed cough was more frequent in advanced disease. This finding suggests a progressive increase in respiratory impairment with advancing sarcoidosis stage, particularly in patients with stage IV disease in whom fibrotic HRCT abnormalities were also present. This most likely reflects disease progression from predominantly granulomatous inflammation toward fibrotic remodeling and airway involvement in advanced sarcoidosis. Similar observations have been described in previous studies demonstrating that advanced sarcoidosis may exhibit imaging features resembling fibrotic interstitial lung diseases [21,22].

HRCT findings from this study further support the relationship between the imaging patterns and the clinical manifestations. Micronodular abnormalities with perilymphatic distribution were more frequent in patients without cough. These findings are consistent with the typical HRCT appearance of pulmonary sarcoidosis, which primarily affects the lymphatic inter-

stitium rather than the airways [10]. As a result, these lesions may produce fewer airway-related symptoms compared with fibrotic processes.

Similarly, micronodular and other nonfibrotic HRCT abnormalities were more frequently associated with absent or less pronounced cough, suggesting that inflammatory or granulomatous patterns may be clinically less symptomatic than fibrotic changes. In contrast, fibrotic HRCT abnormalities such as reticulation, traction bronchiectasis, and architectural distortion were associated with more pronounced respiratory symptoms. These imaging features represent irreversible structural changes of the pulmonary parenchyma and are typical of fibrotic interstitial lung diseases [7,9]. The presence of traction bronchiectasis and fibrotic remodeling may significantly impair pulmonary mechanics and contribute to persistent cough and dyspnea.

Previous studies have described HRCT patterns in pulmonary sarcoidosis and fibrotic interstitial lung diseases, as well as the clinical manifestations of these conditions. However, relatively few studies have specifically evaluated the relationship between cough characteristics and HRCT imaging patterns in both fibrotic interstitial lung diseases and pulmonary sarcoidosis within the same patient cohort.

Another important finding of this study is the strong association between the sarcoidosis stage and the development of fibrotic HRCT changes. Traction bronchiectasis and pulmonary fibrosis were observed almost exclusively in patients with stage IV sarcoidosis. These findings are consistent with previous studies showing that advanced sarcoidosis may evolve into a chronic fibrotic phenotype characterized by irreversible lung damage and progressive respiratory deterioration [22,24].

Walsh et al. demonstrated that HRCT findings such as traction bronchiectasis and fibrotic distortion are strongly associated with advanced sarcoidosis and correlate with reduced pulmonary function [24]. Similarly, Nunes et al. described that stage IV sarcoidosis frequently demonstrates imaging features resembling fibrotic interstitial lung diseases, emphasizing the overlap between advanced sarcoidosis and other fibrotic lung disorders [11,22].

Additionally, smoking status demonstrated an association with the distribution of reticular abnormalities on HRCT in this study. Peripheral and subpleural reticular changes were more fre-

quent in smokers compared with non-smokers. This finding may reflect the well-known role of cigarette smoke as an environmental factor contributing to structural pulmonary injury and fibrotic remodeling of the pulmonary parenchyma.

Previous studies suggest that smoking may influence the development and progression of interstitial lung abnormalities and fibrotic lung diseases [23].

In summary, the findings of this study emphasize the important role of HRCT not only in the diagnosis of diffuse lung diseases but also in understanding their clinical expression. Correlation of imaging patterns with respiratory symptoms may help clinicians better interpret patient presentation, recognize disease progression, and differentiate inflammatory from fibrotic disease phenotypes.

STRENGTHS AND LIMITATIONS OF THE STUDY

This study has several strengths that should be emphasized. First, it provides a comparative analysis of the clinical symptoms and HRCT imaging findings in two important groups of diffuse lung diseases, namely fibrotic interstitial lung diseases (UIP and NSIP) and pulmonary sarcoidosis. The comparative evaluations of these conditions are relatively limited in the literature, and this study contributes to a better understanding of the relationship between radiological patterns and clinical manifestations.

Second, the study integrates both clinical and imaging data, enabling a comprehensive evaluation of the correlation between the respiratory symptoms and HRCT findings. This combined clinical-radiological approach reflects the multidisciplinary nature of diffuse lung disease diagnostics, in which imaging plays a central role in disease characterization and patient management.

Another strength of the study is the detailed assessment of HRCT abnormalities according to their anatomical distribution, including peribronchovascular, peripheral, subpleural, and central patterns. Such detailed radiological analysis allows more precise characterization of the imaging patterns and their potential association with specific clinical manifestations.

However, several limitations should also be considered. The study was conducted in a single tertiary referral center, which may limit the generalizability of the results to other patient populations. Additionally, the retrospective design of the study may introduce potential selection bias, since clinical data were obtained from previously recorded medical documentation.

Another limitation is the relatively small number of patients in certain subgroups, particularly within individual sarcoidosis stages, which may reduce statistical power for detecting differences between groups. Furthermore, cough characteristics were based on questionnaire data and may have been subject to reporting bias. In addition, the study mainly relied on radiological evaluation, and histopathological confirmation was not available in all cases.

Moreover, the use of radiographic rather than HRCT-based grading of sarcoidosis represents a methodological limitation; however, a universally accepted HRCT-based grading system for sarcoidosis has not yet been established.

Despite these limitations, the results of this study emphasize the importance of correlating HRCT imaging patterns with clinical manifestations in patients with diffuse lung diseases and provide insights that may contribute to improved understanding of disease behavior and progression.

CONCLUSION

In conclusion, this study demonstrates that respiratory symptoms in diffuse lung diseases are significantly associated with HRCT imaging patterns and underlying pathological processes. Fibrotic interstitial lung diseases, particularly UIP, were associated with more pronounced respiratory symptoms, including persistent and productive cough, reflecting the degree of fibrotic remodeling of the lungs. In contrast, pulmonary sarcoidosis demonstrated a broader clinical spectrum, with milder symptoms in the early stages and increasing respiratory impairment in advanced stages accompanied by fibrotic HRCT changes. These findings emphasize the important role of HRCT not only in the diagnosis of diffuse lung diseases but also in understanding their clinical presentation and progression, high-

lighting the value of integrating imaging findings with clinical evaluation in patient management.

Conflict of Interest

The author declares no conflict of interest.

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Резиме

КОРЕЛАЦИЈА МЕЃУ КАРАКТЕРИСТИКИТЕ НА КАШЛИЦАТА И ХРЦТ-ПАТЕРНИТЕ КАЈ ФИБРОТИЧНИ ИНТЕРСТИЦИЕЛНИ БЕЛОДРОБНИ ЗАБОЛУВАЊА И КАЈ ПУЛМОНАЛНА САРКОИДОЗА

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Вовед: Фибротичните интерстициелни белодробни заболувања и пулмоналната саркоидоза претставуваат дифузни белодробни нарушувања со различни патолошки и радиолошки патерни. Компјутеризираната томографија со висока резолуција (ХРЦТ) има централна улога во евалуацијата на овие состојби, овозможувајќи детална процена на паренхимските абнормалности и нивната дистрибуција.

Цел: Да се евалуира врската меѓу карактеристиките на кашлицата и ХРЦТ-имицинг патерни кај пациентите со фибротични интерстицијални белодробни заболувања (ИББ) (УИП и НСИП) и пулмоналната саркоидоза.

Материјали и методи: Оваа ретроспективна опсервациска студија опфати 120 пациенти со дифузни белодробни заболувања дијагностицирани на Универзитетската клиника за пулмологија и алергологија во Скопје, од кои 70 пациенти со фибротични интерстициелни белодробни заболувања (УИП и НСИП) и 50 пациенти со пулмонална саркоидоза. Клиничките податоци беа собрани со помош на структуриран прашалник, кој ги опфаќаше карактеристиките на кашлицата, диспнеата, пушачкиот статус и скалата за диспнеа МРЦ. ХРЦТ-снимките беа анализирани за присуство на ретикуларни промени, опатитети млечно стакло, микронодули, консолидации, хипоатенуација, тракциска бронхиектазии, фиброза и сакесто белодробие. Поврзаноста меѓу клиничките варијабли и ХРЦТ наодите беше анализирана со тест χ^2 и со тестот Fisher exact. Р-вредностите помеѓу 0,05 и 0,1 се интерпретираа како показател за статистичкиот тренд.

Резултати: Кашлицата беше присутна кај приближно 80 % од пациентите со фибротични интерстициелни белодробни заболувања. Продуктивната кашлица беше почеста кај UIP, додека сувата кашлица беше почеста кај NSIP. Кај пулмоналната саркоидоза сувата кашлица доминираше во раните стадиуми, додека продуктивна или мешана кашлица беше почеста во напреднатата болест. Диспнеата беше многу честа кај фибротичните ИББ и се зголемуваше со стадиумот на саркоидоза. ХРЦТ-патерните карактеризирани со перилимфатични и перибронховаскуларни микронодули беа почесто забележани кај пациентите без кашлица, додека фибротичните абнормалности, вклучувајќи тракциски бронхиектазии и пулмонална фиброза, беа поврзани со поизразени респираторни симптоми.

Заклучок: Респираторните симптоми кај дифузните белодробни заболувања покажуваат значајна поврзаност со имицинг патернитем HRCT. Фибротичните интерстициелни белодробни заболувања се поврзани со поизразена кашлица и диспнеа, додека пулмоналната саркоидоза покажува поблаги симптоми во раните стадиуми и зголемено респираторно оштетување во напреднатите стадиуми.

Клучни зборови: компјутеризирана томографија со висока резолуција, интерстициелна белодробна болест, вообичаена интерстициелна пневмонија, неспецифична интерстициелна пневмонија, пулмонална саркоидоза, кашлица