AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

SPIROMETRIC CHARACTERISTICS OF NON-SPECIFIC INTERSTITIAL PNEUMONIA

Makhmatmuradova N.N.
Samarkand State Medical University, Uzbekistan
E-mail: makhmatmuradova@bk.ru

Abstract. This article examines the evaluation of key spirometric parameters in patients with nonspecific interstitial pneumonia. It has been established that these patients predominantly exhibit restrictive pulmonary ventilation impairments, characterized by decreased forced vital capacity and forced expiratory volume in the first second, with a relatively preserved Tiffeneau index. The findings confirm the diagnostic value of spirometry in assessing lung function in patients with interstitial lung diseases.

Keywords: nonspecific interstitial pneumonia, spirometry, FVC, FEV1, restrictive impairments.

Introduction. Currently, a heterogeneous group of interstitial lung diseases encompasses pathological processes based on inflammation and fibrosis of the pulmonary interstitium [12]. Within the international classification of idiopathic interstitial pneumonias, nonspecific interstitial pneumonia is recognized as a distinct entity. Its course, in contrast to idiopathic pulmonary fibrosis, is characterized by a relatively more favorable prognostic outcome [9].

Furthermore, pathological processes in the lungs, characterized by diffuse inflammation of the alveolar septa and the development of interstitial fibrosis, underlie this disease. These changes cause loss of elasticity of lung tissue and a reduction in the volume of functioning parenchyma, which negatively impacts the ventilatory capacity of the lungs [13].

Spirometry is currently a key method for assessing the state of the respiratory system. It allows for the precise identification of the type of ventilation impairment and the assessment of its severity [1,16]. In the context of interstitial lung diseases, restrictive ventilation impairment is the most common. It is characterized by a decrease in vital capacity (VC) and forced vital capacity (FVC) [11].

Interstitial lung diseases are also the subject of extensive scientific research, and the problem of adequate functional assessment of the respiratory system, particularly in nonspecific interstitial pneumonia (NIP), remains relevant. In this context, analysis of spirometric data is critical, serving both as a diagnostic tool and a key element in patient monitoring [3,8].

Materials and methods. Patients with a confirmed diagnosis of nonspecific interstitial pneumonia were studied. Based on the severity of the disease, patients were categorized as mild (NIPMC), moderate (NIPMS), and severe (NIPSC). Diagnosis was based on clinical data, high-resolution computed tomography of the lungs, and laboratory and instrumental studies in accordance with current international guidelines [7, 10].

Respiratory system function was measured using spirometry with a computerized spirometer. This study was conducted in full compliance with respiratory function testing guidelines. The following parameters were measured and assessed: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), Tiffeneau index (FEV1/FVC), peak expiratory flow rate (PEF), and maximum expiratory flow rate at 25–75% of FVC (MXEF). All obtained values were expressed as percentages of standard (target) values. Statistical analysis of the data was performed using variation statistics.

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Results. Spirometry was performed in patients with NIP (n=140) to determine impairment of external respiratory function (ERF). Mean ERF values are presented in Table 1.

Table 1.

ERF parameters in patients with NIP

Indicator	NIPMC, n=16	NIPMS, n=59	NIPSC, n=65
FVC 1, %	75,68±3,76	74,23±1,69	70,61±1,01
FVC 1, %*	107,41±12,76	84,02±21,56	74,93±17,41
PEF, %	79,81±3,23	78,81±1,53	75,47±0,88
PEF, %*	104,12±12,18	88,79±16,38	77,36±14,57
MXEF 50, %	44,75±5,0	41,58±2,06	37,5±1,58
MXEF 50, %*	93,18±23,44	51,05±24,02	38,33±18,42
MXEF 75, %	34,06±5,28	31,36±2,19	27,25±1,69
MXEF 75, %*	77,08±30,51	35,36±21,87	21,05±14,41
MEF 25-75, %	43,25±5,74	40,7±2,55	34,93±1,91
MEF 25-75, %*	92,07±24,41	50,11±25,13	32,08±17,11
FVC 1/ FVC, %	78,21±7,87	62,45±8,13	60,43±11,96
FVC 1/ FVC, %*	84,62±7,38	69,36±11,87	64,15±7,88

*Note: * - measured after inhalation of a bronchodilator; ** - the mean value and standard deviation (M + σ) are given for samples characterized by normal distribution.*

According to the results of the study, all groups of patients had a pronounced impairment of external respiratory function (ERF).

In 20.83% of the examined patients in the NIPMC group, the FVC and FVC-1 indices decreased partially or moderately. An increase in the Tiffeneau index by more than 70% and a decrease in the FVC and FVC-1 indices by less than 75% were observed in 32.18% of patients with NIPSC and in 36.25% with NIPMS, which indicates a restrictive nature of the ERF disorder. In 28.33% of patients with NIPMC and 16.25% of patients with NIPMS, the changes were of a mixed nature (more restrictive). Obstructive disorders were detected in 14.17% of patients with NIPMC. A decrease in bronchial patency was observed in 18.33% of patients with NIPMC and in 14.17% of patients with NIPMS.

In patients in the comparison group (hypertension and coronary heart disease), respiratory function impairment was more pronounced. Decreases in FVC and FVC-1 were observed in 16.38% of patients, while moderate and mild impairments were detected in 14.89%.

Specifically, an increase in the Tiffeneau index of more than 70% and a decrease in FVC-1 of more than 75% were detected in 7.45% of patients. In 13.83% of patients, a decrease in the

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Tiffeneau index was observed, with a normal FVC index (n=4) or a decrease of less than 75% (n=9), which is typical of obstructive or mixed types of respiratory failure.

Thus, the FVC, FVC-1, MXEF 25, MXEF 50, and MXEF 75 indices were significantly higher in patients in the NIPMC group and in the control groups ($p < 0.05$). A decrease in the FVC index was observed in 20.83% of patients with NIPMC, which was more pronounced in individuals with rheumatic pathology. A Tiffeneau index greater than 70% and a decrease in FVC and FVC-1 greater than 75% are considered a sign of NIPSC in 32.18% of patients, and was observed in 36.25% of patients with NIPMS, which is typical of restrictive ERF disorders.

Mixed changes (more restrictive) were observed in 28.33% of patients with NIPMC and 16.25% of patients with NIPMS. Bronchial patency was impaired in 18.33% of patients with NIPMC and 14.17% of patients with NIPMS. In the comparison group, a mixed type of ventilation impairment was predominantly observed, with obstructive impairment predominating, but restrictive impairments were also detected in some cases (7.45%).

As a result, analysis of spirometric data revealed that most patients had signs of restrictive breathing problems. This was confirmed by the fact that the mean forced vital capacity (FVC) was significantly lower than normal (approximately 60-70% of the predicted value), indicating a decrease in lung capacity. The volume of air exhaled in the first second (FEV1) was also reduced to 65-75% of the predicted value.

In restrictive ventilation disorders, as shown in [2], a proportionate decrease in FEV1 and FVC is observed, which maintains the Tiffeneau index within normal limits (80–90%) or even leads to a slight increase. Additionally, a moderate decrease in peak and maximum expiratory flow rates is noted. These functional changes in the respiratory system in interstitial lung diseases are consistent with data from other studies [15].

Discussion. The results of the studies indicate that the restrictive type of ventilation disorders is the dominant functional deficit in nonspecific interstitial pneumonia. The main pathophysiological mechanism underlying these changes is a decrease in lung tissue compliance caused by the interstitial inflammatory process and the development of fibrotic changes [5, 14]. A decrease in lung volumes, in particular, leads to a decrease in the total vital capacity of the lungs (TVC) and forced vital capacity (FVC), which is recorded during a spirometric study. At the same time, the Tiffeneau index (the ratio of FEV1 to FVC) remains within the normal range or shows a tendency to increase, since the decrease in FEV1 occurs proportionally to the decrease in FVC [4]. These results correlate with the data of other studies aimed at the functional diagnostics of interstitial lung diseases [6].

Conclusion. Therefore, when examining patients with nonspecific interstitial pneumonia, we typically see that their lungs are volume-limited, a condition known as restrictive ventilation. Spirometry reveals this as a decrease in forced vital capacity and forced expiratory volume in the first second. Importantly, the Tiffeneau index remains within the normal range. Thus, spirometry serves as a key tool for both diagnosis and for effectively monitoring the patient's condition and assessing the effectiveness of treatment.

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