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Research Article

Does Sjögren's Syndrome Reduce Lung Volume Measured by Computed Tomography Volumetry After a 5-Year Period?

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ABSTRACT

Objective: The aim of the study was to measure the lung volume of patients with a diagnosis of Sjögren's syndrome using quantitative lung computed tomography volumetry and to compare lung volumes of patients with or without lung involvement which were computed from initial chest computed tomography and last chest computed tomography obtained at least 5 years later.

Methods: After obtaining institutional review board approval, patients with Sjögren's syndrome who underwent chest computed tomography twice over at least a 5-year period between November 2012 and November 2022 were retrospectively included in the study. A total of 37 patients with Sjögren's syndrome were separated into 2 groups: the lung involvement group (22 patients) and the normal lung group (15 patients). A vast majority of the study participants were female (36 females and 1 male). The mean age of the study population was 54 ± 8.9 months. Total, right, and left lung volumes were calculated using automated software (*Pulmo 3D* and *Syngo via*). Computed tomography images were evaluated by 2 radiologists to understand whether there was lung involvement by consensus. Lung volumes measured from the initial and last computed tomographies were compared in both groups.

Results: Total, right, and left lung volumes measured from the initial and last computed tomographies were not statistically different in both groups (*P* values are .238, .271, .294, .123, .213, and .511, respectively). However, when the lung volumes of patients with Sjögren's syndrome are compared between normal lung group and lung involvement group, patients with lung involvement have lower lung volume values than patients without lung involvement (*P* = .034 for total lung volume).

Conclusion: Regardless of the lung involvement, the lung volumes of patients with Sjögren's syndrome were not significantly different after at least 5 years. Sjögren's syndrome patients with lung involvement have smaller lung volumes when compared to the counterparts without lung involvement.

Keywords: Chest CT, lung volume, Sjögren's syndrome, volumetry

INTRODUCTION

Sjögren's syndrome is an autoimmune disease characterized by lymphocytic infiltration of lacrimal and salivary glands. Pulmonary involvement is frequent in Sjögren's syndrome, and its pattern can be evaluated via chest computed tomography (CT) or high resolution computed tomography (HRCT).[1,2] When interstitial lung disease is detected, the course of the disease can be monitored with CT.

Lung volume can be measured using spirometry as a respiratory function test. Lung volume can also be measured using quantitative lung CT volumetry.[3] The lung volume calculated using CT volumetry is well correlated with the values measured using spirometry.[4] Computed tomography volumetry is also utilized for the quantification of emphysema.[5,6] The relationship between CT findings and pulmonary function tests in patients having Sjögren's syndrome has already been studied by some researchers.[7-9] A recent study by Ufuk et al evaluated Sjögren's syndrome-related interstitial lung disease with quantitative CT analysis, providing the percentage of involved parenchyma.[10]

We think that the lung volume of Sjögren's syndrome patients with pulmonary involvement may decrease along with the disease course. So, we aimed to measure the

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lung volume of patients with a diagnosis of Sjögren's syndrome via quantitative lung CT volumetry and to compare lung volumes of patients with or without lung involvement, which were calculated from the initial chest CT and the last chest CT obtained at least 5 years later.

METHODS

Ethics committee approval was received for this study from Selçuk University Local Ethics Committee (December 20, 2022; Decision number: 2022/504). Informed consent is waived because of the retrospective study design.

A computerized search of the database at our institute was performed to identify patients who had undergone chest CT with a diagnosis of Sjögren's syndrome from November 2012 to November 2022. Sixty-eight patients were identified. Among these patients, we enrolled the patients who had at least 2 chest CT scans with a minimum interval of 5 years. We excluded patients with pleural effusion, atelectasis, and a history of thoracic surgery or radiotherapy, which could affect lung volume. Also, we excluded expiratory chest CT scans.

Seventeen patients were excluded from the study because the interval was shorter than 5 years. We excluded 11 patients because of an expiratory chest CT scan. A patient with severe Coronavirus-2019 infection and 2 patients with pleural effusion were also excluded from the study. The remaining 37 patients with a diagnosis of Sjögren's syndrome were separated into 2 groups based on whether lung involvement was present or not (Figure 1). Twenty-two patients were encountered without lung involvement. In the lung involvement group, the number of patients with usual interstitial pneumonia, nonspecific interstitial pneumonia, organizing pneumonia, lymphoid interstitial pneumonia, and nonspecific involvement patterns was 3, 3, 2, 4, and 3, respectively (Figure 2). The presence of only ground glass opacities or reticular densities on CT is classified as a nonspecific involvement pattern.

MAIN POINTS

- The lung volume of patients with Sjögren's syndrome—regardless of lung involvement—is not significantly different after a 5-year period.
- Sjögren's syndrome patients with lung involvement have smaller lung volume when compared to the Sjögren's syndrome patients without lung involvement.
- A larger study population is needed to evaluate the effect of specific lung involvement patterns on lung volume of patients with Sjögren's syndrome as a further study subject.

The vast majority of the study participants were female (36 females and 1 male). The mean age of the study population was 54 ± 8.9. The mean follow-up duration was 73 ± 6.2 months.

Image Evaluation and Lung Volume Measurements

All CT examinations were performed in our institution (Somatom Scope 16 or Somatom Definition Flash, Siemens Healthcare, Germany). Computed tomography scans were obtained at full inspiration while the patient was in the supine position. Typical chest CT image acquisition parameters were 80-130 kVp, 100-250 mAs, 1.2-mm collimation, 3-mm slice thickness, 2-3 mm reconstruction interval, and a pitch of 1-1.5.

We excluded expiratory chest CT scans evaluating the membranous trachea to be sure about full inspiration. Then, we separated the remaining study participants into 2 groups according to whether lung involvement was present or not. Typical lung involvement pattern is evaluated by 2 European Board of Radiology-certified radiologists experienced in thoracic imaging according to the latest guideline in consensus.[11]

The post-processing procedure of the chest CT images was performed with the Pulmo-3D *analysis* program (Siemens Medical Systems, Syngo via). Right lung volume (RLV), left lung volume (LLV), and total lung volume (TLV) were measured (Figure 3). Lung volume was measured according to the voxels, with a range of −950 and −200 Hounsfield units.

Statistical Analysis

The Shapiro–Wilk test was used to determine the distribution of continuous variables. Descriptive statistics were used to express the mean values and SD. To compare lung volumes (RLV, LLV, and TLV) between the 2 groups, we performed the Student's *t* and paired samples *t*-tests. A difference was regarded as significant at $P < .05$. Statistical analysis was performed using Statistical Package of the Social Sciences version 23.0 software (IBM SPSS Corp., Armonk, NY, USA).

RESULTS

RLV, LLV, and TLV values measured from the initial and last chest CTs in patients without lung involvement were not statistically significant ($P = .294$, $P = .213$, and $P = .238$, respectively). Right lung volume, LLV, and TLV values computed from the initial and last chest CTs in the lung involvement group did not show a statistically significant difference ($P = .123$, $P = .511$, and $P = .271$, respectively).

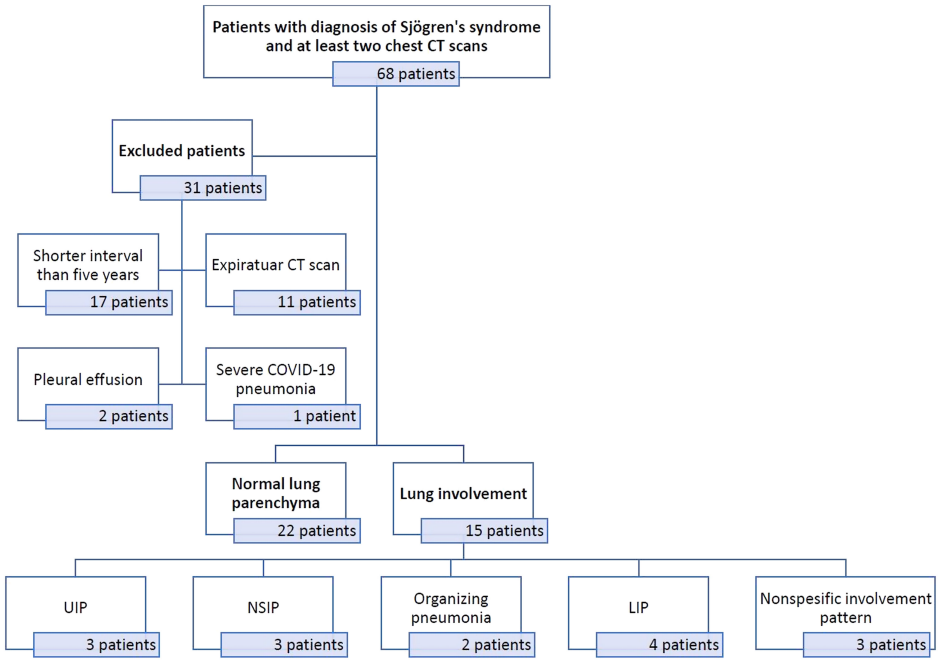


Figure 1. The flowchart depicts the distribution of the study population.
UIP, usual interstitial pneumonia; NSIP, nonspesific interstitial pneumonia; LIP, lymphoid interstitial pneumonia.

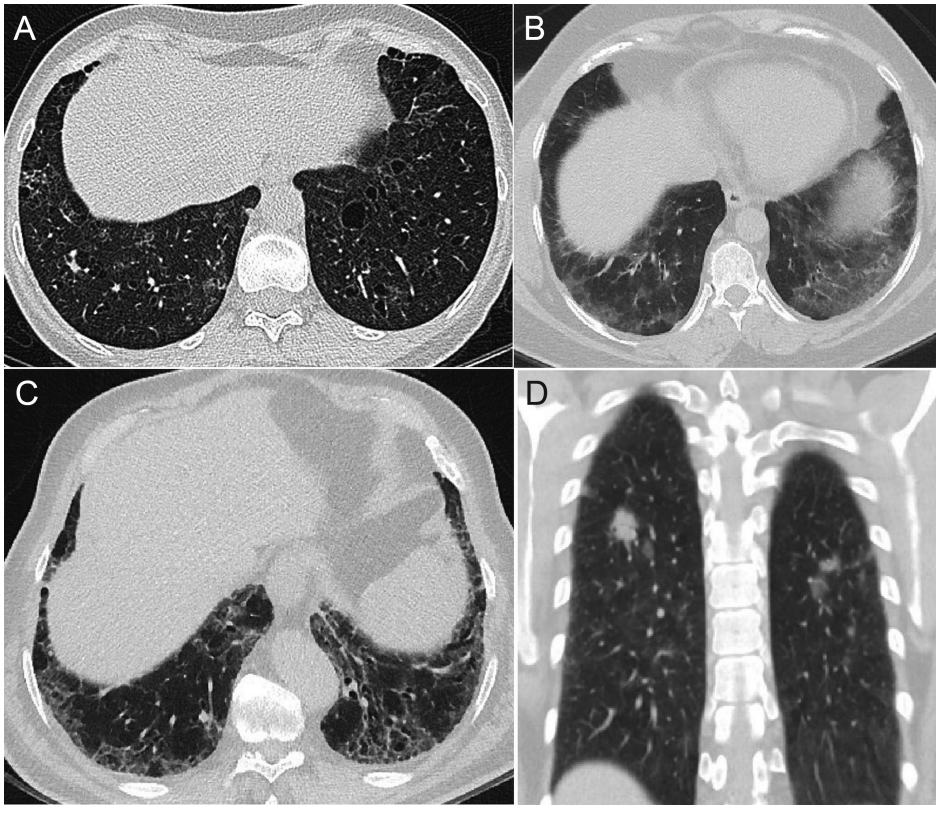
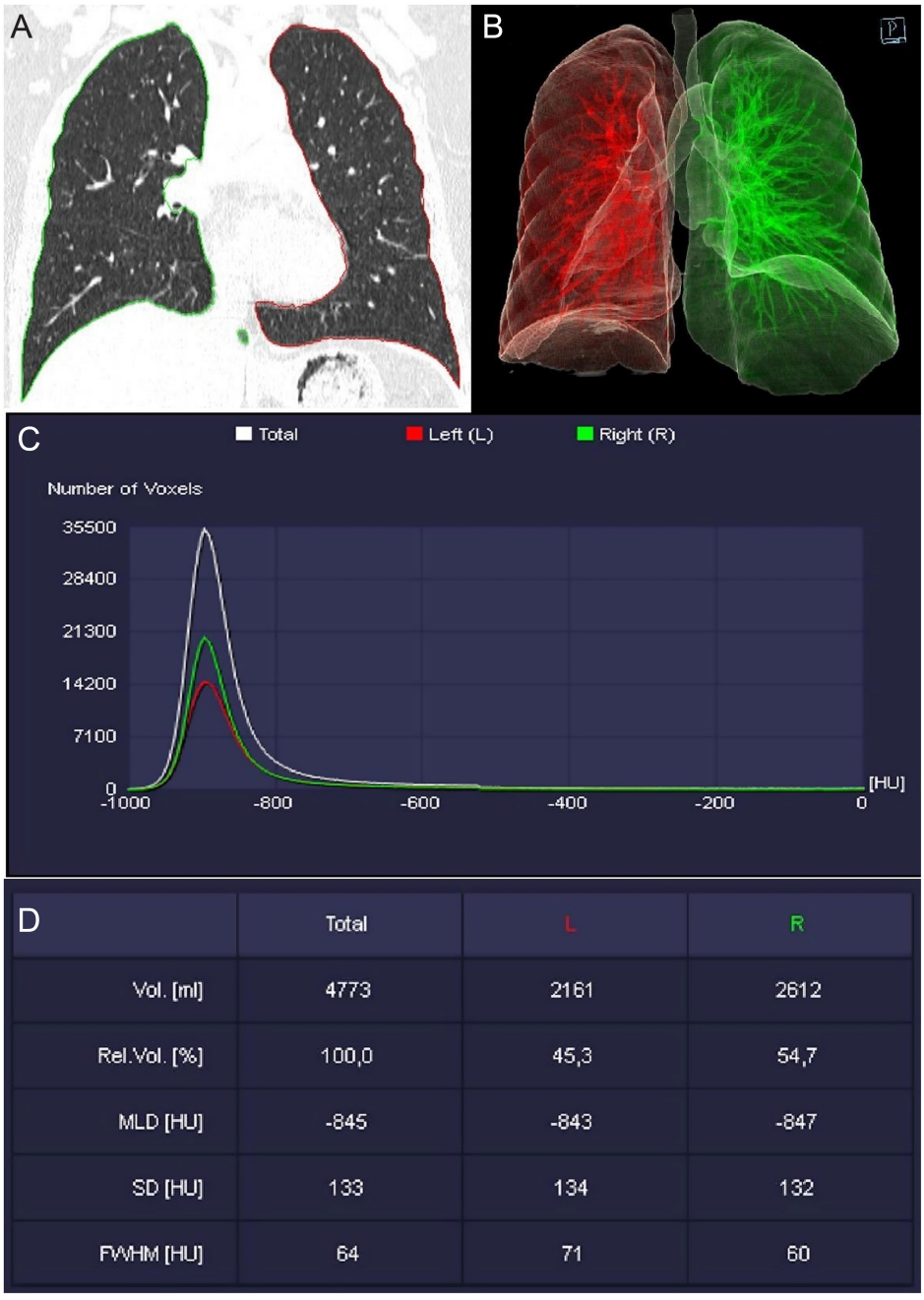


Figure 2. Axial or coronal chest CT images demonstrating lung involvement pattern. (A) Air cysts and some ground glass areas suggest lymphoid interstitial pneumonia (LIP). (B) Large ground glass areas and a few traction bronchiectasis in both lower lobes did not regress in the follow-up which suggest nonspesific interstitial pneumonia (NSIP). (C) Subpleural reticular densities and traction bronchiectasis with a few microcyst in both lower lobes suggesting probable usual interstitial pneumonia (UIP). (D) Focal consolidation areas disappearing and recurring in different zones in follow-up CT suggesting organizing pneumonia.



	Total	L	R
Vol. [ml]	4773	2161	2612
Rel.Vol. [%]	100,0	45,3	54,7
MLD [HU]	-845	-843	-847
SD [HU]	133	134	132
FWHM [HU]	64	71	60

Figure 3. (A) Pixels corresponding to lung parenchyma are limited with a green or red line. (B) Volume rendered technique image shows the right lung depicted in green and the left lung depicted in red. (C) A histogram depicts the distribution of the Hounsfield unit (HU) of voxels for both lungs. (D) The table shows the lung volume of a 55-year-old female patient without lung involvement.
MLD, mean lung density; SD, standard deviation; FWHM, Full width half maximum.

Lung volume values are provided in Table 1 with statistical test results. On the other hand, when the lung volumes are compared between normal lung and lung involvement groups, statistically significant results are revealed, as shown in Table 1.

In the lung involvement group, we also provided the lung volume values according to specific involvement patterns (Table 2). We did not perform statistical analysis because of the small patient number in these subgroups.

DISCUSSION

The present research utilizes CT volumetry to assess the lung volume of patients with Sjögren's syndrome. The study's main conclusion is that the lung volumes

Table 1. Lung Volume Values of Patients with Sjögren's Syndrome

Patients with Sjögren's Syndrome (n = 37)	Lung Volume (cm^3) (Mean ± SD)								
	Right Lung Volume			Left Lung Volume			Total Lung Volume		
	Initial CT	Last CT	P*	Initial CT	Last CT	P*	Initial CT	Last CT	P*
Normal lung (n = 22)	2341 ± 405	2292 ± 410	.294	2058 ± 372	2001 ± 374	.213	4399 ± 762	4294 ± 771	.238
Lung involvement (n = 15)	2068 ± 517	1955 ± 593	.123	1700 ± 436	1656 ± 526	.511	3769 ± 944	3617 ± 1097	.271
P†	.082	**.048**	NA	**.011**	**.025**	NA	**.032**	**.034**	NA

*Paired samples t-test. † Student's t test. CT, computed tomography; NA, Not applicable. Bold means $P < .05$.

Table 2. Lung Volume Values of Patients with Sjögren's Syndrome According to Lung Involvement Pattern

Dominant Lung Involvement Pattern of Patients with Sjögren's Syndrome (n = 12)	Lung Volume (cm^3) (Mean ± SD)					
	Right Lung Volume		Left Lung Volume		Total Lung Volume	
	Initial CT	Last CT	Initial CT	Last CT	Initial CT	Last CT
Usual interstitial pneumonia (n = 3)	2228 ± 785	2196 ± 1110	1864 ± 683	1869 ± 950	4093 ± 1462	4099 ± 2005
Lymphoid interstitial pneumonia (n = 4)	1958 ± 564	2067 ± 395	1695 ± 509	1907 ± 406	3653 ± 1058	3974 ± 787
Organizing pneumonia (n = 2)	2550 ± 170	2390 ± 484	1995 ± 124	1859 ± 292	4545 ± 294	4249 ± 777
Nonspecific interstitial pneumonia (n = 3)	1930 ± 374	1646 ± 387	1476 ± 248	1281 ± 335	3406 ± 622	2927 ± 720

CT, computed tomography.

of Sjögren's syndrome patients with and without lung involvement are significantly different. Another finding of the current study was that, regardless of lung involvement, there was no statistically significant change in the lung volume after at least 5 years of follow-up.

There are a few studies about pulmonary function tests and CT findings in patients with Sjögren's syndrome. Ozdemirel et al reported that functional parameters (forced vital capasity [FVC], forced expiratory volume [FEV1], and FEV1/FVC) of patients suffering from Sjögren's syndrome were not significantly different irrespective of whether there were CT findings or not.[7] On the contrary, another study revealed that pulmonary function tests were abnormal in 65% of those with HRCT findings, while 71.4% of those with normal HRCT had normal pulmonary function tests.[9] Taouli et al[8] evaluated pulmonary function tests of patients with Sjögren's syndrome and compared pulmonary function tests between patients with interstitial fibrosis (n = 7) and LIP (n = 5) patterns on CT. They reported that total lung capacity (TLC), FVC, and FEV1 values were significantly smaller in patients with LIP, while the FEV1/FVC rate was significantly higher in patients with LIP. In our results, we also provided lung volume values according to the CT involvement pattern (UIP, NSIP, LIP, and organizing pneumonia) but did not perform statistical analysis because of the small sample size in subgroups.

We hypothesized that a significant decrease in lung volume may be observed after 5 years of follow-up, especially in the lung involvement group. However, our study results did not support this hypothesis. On the other hand, the lung volumes in the lung involvement group were significantly smaller than those of the patients without lung involvement. So, we can speculate that before the first chest CT scan, maybe the patient suffered for some time (maybe for years) without a diagnosis of Sjögren's syndrome. Furthermore, the first chest CT evaluation in this study was not performed at the exact time of the diagnosis of the disease. Another issue is that steroid or immunomodulatory treatment may prevent the progression of lung involvement. Taking medicine for the treatment of Sjögren's syndrome is not taken into account throughout the study as a major limitation.

The limitations of this study are the small study population and the retrospective study methodology. As a restriction, the involvement pattern was based only on CT imaging rather than histopathological assessment. Another limitation is the absence of spirometry data. Also, we did not assess the weight and height of patients with Sjögren's syndrome in both groups, which might have affected the lung volume measured by CT volumetry. Chest CT volumetry may not accurately reflect the functional capacity of the lungs, as it only measures static lung volume and does not take into account the dynamic lung function.

In conclusion, the results of this study showed that the lung volume of Sjögren's syndrome patients regardless of lung involvement did not show a statistically significant difference after at least 5 years of follow-up. However,

we showed that Sjögren's syndrome patients with lung involvement have smaller lung volumes when compared to the counterparts without lung involvement. Further research is needed to better understand the lung volume alterations in patients with a diagnosis of Sjögren's syndrome.

Ethics Committee Approval: Ethics committee approval was received for this study from Selçuk University Local Ethics Committee (Date: December 20, 2022; Decision No.: 2022/504).

Informed Consent: Permission was obtained from the hospital management for the use of patient data.

Peer-review: Externally peer-reviewed.

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Declaration of Interests: The authors declare that they have no competing interest.

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