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Original Article

The Relationship between Airway Resistance and Pulmonary Volumes in Active Phase of Ulcerative Colitis and Crohn's Disease

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ABSTRACT

Background:
Inflammatory bowel disease (IBD) including ulcerative colitis (UC) and Crohn's disease (CD), as an autoimmune disorder, is associated with chronic relapsing inflammation of intestine. UC and CD are associated with gastrointestinal and extra-intestinal symptoms, which may vary in severity of clinical presentation. This study was designed to evaluate airway resistance and pulmonary volumes and capacities in the active phase of UC and CD.

Materials and Methods:
Patients who had IBD and referred to Shahid Modarres Hospital from February 2016 to December 2017 were assessed for enrollment in our study. Diagnosis of Crohn's disease or ulcerative colitis was confirmed by colonoscopic and pathological evaluations. Pulmonary respiratory parameters including first second of forced expiration (FEV1), forced vital capacity (FVC), residual volume (RV), total lung capacity (TLC), forced expiratory flow between 25% and 75% (FEF25-75%), and airway resistance were measured by plethysmography in the first days of admission in patients with stable IBD and also immediately after an initial stabilization of the vital signs in patients with unstable IBD. Data were analyzed using SPSS software (v.21. IBM Inc. IL). *P* value less than 0.05 was considered as statistically significant.

Results:
Of 75 patients with IBD, 65 had UC and 10 had CD. The mean ages of the patients with UC and CD were 37.81 ± 13.31 and 34.20 ± 8.53 years, respectively. Of all the participants, approximately 54.7% and 45.3% of the patients were male and female, respectively. The duration of disease for patients with UC and CD was 43.09 ± 45.86 and 44.40 ± 15.45 months, respectively. Based on the Pearson correlation analysis, there were significant associations between FEV1, TLC, and FEF25-75% with the duration of UC and also between FEV1, RV, and airway resistance with the duration of CD. In patients with CD but not in the patients with UC, there were statistical relationships between FEV1, FVC, FEV1/FVC, RV, RV/TLC, FEF25-75% and increased airway resistance with severity and activation of IBD.

Conclusion:
According to our findings, pulmonary involvements were found often in patients with IBD with and without the presence of clinical pulmonary symptoms. The duration and also activation and severity of IBD can be associated with increased risk for pulmonary involvements.

Keywords: Ulcerative colitis, Crohn's disease, Inflammatory bowel disease, Pulmonary involvement, Extra-intestinal, Respiratory

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INTRODUCTION

Inflammatory bowel disease (IBD) including ulcerative colitis (UC) and Crohn's disease (CD), as an autoimmune disorder, is associated with chronic relapsing inflammation of intestine. UC is confined to the colon and can involve rectum and ileum usually (1-3). The annual incidence and prevalence of UC is 10 to 12 cases and 35 to 100 cases per 100000 populations, respectively. The usual ages of onset for UC are 15-25 and 55-65 years, although it can develop at any age. The exact reason for

UC is unknown, but it seems to be a polygenic and multifactorial disease (1-3). Environmental factors, impairment of immune function, the risk of genetic disorders, the use of non-steroidal anti-inflammatory drugs, vitamin A and E deficiency, and long term psychological stress can be considered as the most important risk factors of UC (1-3).

CD is one of the chronic inflammatory and idiopathic disorders, which can disrupt any part of the digestive tract from the mouth to the anus. It is subject to periods of relapse and remission. The risk of CD is greater in Jewish people, especially in Ashkenazi Jews and in Central European Jews. The highest annual incidence rate of CD is 20.2 per 100000 populations in North America, 12.7 per 100000 people in Europe, and also 5 per 100000 populations in Asia and the Middle East. The first peak time of occurrence of CD is between the ages of 15 and 30 years and the second peak time of occurrence is between 60 and 70 years old, predominantly in women (4-5).

UC and CD are associated with gastrointestinal and extra-intestinal symptoms, which may vary in severity of clinical presentations (6-7). Involvement of musculoskeletal, dermatologic, hepatopancreatobiliary, renal, and pulmonary systems are prevalent (6-7). There are several pulmonary disorders in patients with IBD such as chronic pneumonia, airway obstruction, organizing pneumonia, granulomatous disease, pulmonary vasculitis, pulmonary fibrosis, bronchiectasis, and pulmonary thromboembolism (8-10). Opportunistic infections due to treatment with immunosuppressive drugs can be considered as important causes of pulmonary involvement in UC and CD (8-10).

It cannot be denied that the utilizations of invasive techniques, such as transbronchial lung biopsy and bronchoalveolar lavage, and expensive methods such as high-resolution computed tomography in patients with IBD with or without pulmonary symptoms are not economical (9-12). Therefore, evaluation of pulmonary system by using more simple methods such as plethysmography and spirometry can be practical and economic (9-12). Recent investigations suggested numerous pulmonary involvements in patients who suffered from IBD, although there is not any report regarding the specific type of pulmonary disease as a dominant pulmonary involvement in such patients (13). This study was designed to evaluate airways resistance and pulmonary volumes and capacities in the active phase of UC and CD.

MATERIALS AND METHODS

Patient selection

This analytical descriptive study was approved at Review Board of Shahid Beheshti University of Medical Sciences (SBUM), Tehran, Iran. After taking the informed consent from patients who had IBD and referred to Shahid Modarres Hospital from February 2016 to December 2017, they were assessed for enrollment in our study. Diagnosis of Crohn's disease or ulcerative colitis was confirmed by colonoscopic and pathological evaluations.

Exclusion criteria

Patients with incomplete medical records were excluded. Moreover, cases with recent pneumonia, lung cancer, chronic obstructive pulmonary disease, occupational diseases such as pneumoconiosis, gastrointestinal reflux disease, cardiovascular diseases including heart failure or valvular disease, body mass index more than 35 Kg/m^2, history of cardiovascular and thoracic surgery, and history of heavy smoking were excluded either.

Study protocol and statistical analysis

Ten cases affected with CD and 65 suffering from UC were enrolled in this study. Pulmonary respiratory parameters including forced expiratory volume for 1 second (FEV1), forced vital capacity (FVC), residual volume (RV), total lung capacity (TLC), forced expiratory flow between 25% and 75% (FEF25-75%), and airway resistance were measured by plethysmography in the first days of admission in patients with stable IBD and also immediately after an initial stabilization of the vital signs in patients with unstable IBD. FVC, TLC, and FEV1 less than 80% of predicted, FEF25-75% less than 50% , FEV1/FVC less than 70% of predicted , and RV/TLC more than 35% of predicted were considered as abnormal pulmonary parameters. Air retention were defined as RV more than 120% of predicted, or RV/TLC more than 35% of predicted, and also small airway obstruction were defined as MMEF25-75 (FEF 25-75) less than 50% of predicted.

If FEV1/FVC is less than 70% of predicted, and

Table 1: Details of pulmonary parameters in patients with UC and CD

Parameters	UC	CD	*P* value
FEV1	78.61 ± 15.54	80.40 ± 8.83	0.725
FVC	84.84 ± 11.43	91.80 ± 6.94	0.066
FEV1/FVC	76.69 ± 9.44	73 ± 4.61	0.231
RV	112.38 ± 23.44	119 ± 8.96	0.383
TLC	90.24 ± 11.57	96.90 ± 6.59	0.081
RV/TLC	38.38 ± 14.74	35.40 ± 5.48	0.053
FEF25-75	67.38 ± 25.09	57.20 ± 13.98	0.216
Airway resistance	137.87 ± 50.95	113.90 ± 40.88	0.161

UC: Ulcerative colitis, CD: Crohn's disease, FEV1: First second of forced expiration, FVC: Forced vital capacity, RV: Residual volume, TLC: Total lung capacity, FEF25-75%: Forced expiratory flow between 25% and 75%.

FEV1 is less than 80% of predicted, this status was considered as obstructive pattern. If FEV1/FVC is normal or greater than 70% of predicted and FVC is less than 80% of predicted, this pattern was considered as restrictive pattern.

Demographic data such as age, sex, duration of disease, administered medications, and presence or non-presence of symptoms of pulmonary disease were evaluated and recorded in a questionnaire for each patient during the study period. The duration of IBD was considered from the time of initial confirmed-diagnosis of UC or CD by using colonoscopy and pathology. Activity of CD and UC was determined based on Crohn's disease activity index (CDAI) and Truelove criteria, respectively.

The analysis of the parametric data was expressed based on the mean and standard deviation. Qualitative and classified data were presented based on the number and percentage and the univariate analysis on quantitative and qualitative data using Student's t test and Chi-square test, respectively. Data were analyzed using SPSS software (v.21. IBM Inc. IL). *P* value less than 0.05 was considered as statistically significant.

RESULT

Seventy five patients who had confirmed diagnosis of IBD according to colonoscopic and pathological findings from March 2016 to November 2017 were enrolled in our study. Of them, 65 cases had UC and the other 10 cases had CD. The mean ages of the patients with UC and CD were 37.81 ± 13.31 and 34.20 ± 8.53 years, respectively. Of all the participants, 54.7% and 45.3% were male and female, respectively. Of the 65 cases with UC, 47.7% were male. All of the cases with CD were male. The body mass index was 24.64 ± 2.60 and 24.47 ± 1.75 in patients with UC and CD, respectively. There was not any significant difference regarding the demographic characteristics among the patients.

Of all cases with UC, 60 patients were receiving treatment with oral medications. 40 cases (61.5%) used 5-aminosalicylic acid alone, 11 cases (16.9%) used 5-aminosalicylic acid and corticosteroid, 5 cases (7.7%) used 5-aminosalicylic acid and corticosteroid and azathioprine, and 2 cases (3.1%) used corticosteroid alone. Only one patient (1.5%) was receiving treatment with combined therapy of azathioprine and corticosteroid. All the patients with CD (100%) used 5-aminosalicylic acid alone.

No significant differences in the pulmonary parameters were found between the patients with UC and CD ($p > 0.05$ for all parameters) (table 1). There were left sided colitis, pan colitis, and proctosigmoiditis in 38 cases (58.8%), 9 cases (13.8%), and 18 cases (27.7%) with UC, respectively. All patients (100%) with CD had ileocolitis. There was not any significant difference for each pulmonary parameter in different types of involvement of UC or CD. Details about airway resistance and pulmonary volumes are presented in table 2 completely.

Of 17 patients with UC, who had normal spirometry, there were 5 patients (29.4%), 10 patients (58.8%), and 2 patients (11.8%) with proctosigmoiditis, left-sided colitis, and pan-colitis, respectively.

Air retention was the most common pattern of pulmonary involvement in patients with proctosigmoiditis (8 cases), and left-sided colitis (10 cases). Distribution of participants by patterns of pulmonary involvement and types of UC have

Table 2: Details of pulmonary parameters according to types of UC and CD

Parameters	Type of UC	Mean ± Standard deviation	*P* value
FEV1	Proctosigmoiditis	80 ± 7.23	0.62
	Left colitis	79.05 ± 17.10	
	Pancolitis	74 ± 20.97	
FVC	Proctosigmoiditis	86.05 ± 7.27	0.70
	Left colitis	84.92 ± 12.85	
	Pancolitis	82.11 ± 12.54	
FEV1/FVC	Proctosigmoiditis	78.66 ± 6.46	0.33
	Left colitis	76.65 ± 8.51	
	Pancolitis	72.88 ± 16.27	
RV	Proctosigmoiditis	112.94 ± 20.35	0.90
	Left colitis	111.44 ± 22.98	
	Pancolitis	115.22 ± 32.57	
TLC	Proctosigmoiditis	92.50 ± 10.28	0.51
	Left colitis	89.92 ± 12.75	
	Pancolitis	87.11 ± 8.49	
RV/TLC	Proctosigmoiditis	41.05 ± 24.87	0.62
	Left colitis	37.76 ± 8.40	
	Pancolitis	35.66 ± 8.42	
FEF25-75	Proctosigmoiditis	65.27 ± 16.41	0.26
	Left colitis	65.36 ± 26.28	
	Pancolitis	80.11 ± 32.56	
Airway resistance	Proctosigmoiditis	140.33 ± 44.63	0.11
	Left colitis	144.39 ± 49.91	
	Pancolitis	105.44 ± 60.15	
Parameters	**Type of CD**	**Mean ± Standard deviation**	***P* value**
FEV1	Ileocolitis	80.4 ± 8.83	-
FVC	Ileocolitis	91.8 ± 6.94	-
FEV1/FVC	Ileocolitis	73 ± 4.61	-
RV	Ileocolitis	119 ± 8.96	-
TLC	Ileocolitis	96.9 ± 6.59	-
RV/TLC	Ileocolitis	35.4 ± 5.48	-
FEF25-75	Ileocolitis	57.2 ± 13.98	-
Airway resistance	Ileocolitis	113.9 ± 40.88	-

UC: Ulcerative colitis, CD: Crohn's disease, FEV1: First second of forced expiration, FVC: Forced vital capacity, RV: Residual volume, TLC: Total lung capacity, FEF25-75%: Forced expiratory flow between 25% and 75%.

been presented in table 3. Seven patients (70%) with CD had normal spirometry and three patients (30%) had obstruction plus small airway obstruction plus air retention as pattern of pulmonary involvements. There were not considerable relationships between the types of involvement of gastrointestinal tract in patients with UC and CD with patterns of pulmonary involvement ($p = 0.106$ for UC and $p > 0.05$ for CD).

The durations of disease for patients with UC and CD were 43.09 ± 45.86 and 44.40 ± 15.45 months, respectively. Based on the Pearson correlation analysis, there were significant association between FEV1, TLC, and FEF25-75% with the duration of UC and also between FEV1, RV, and airway resistance with the duration of CD (table 4).

Of the all patients with UC, 52 (81.3%) did not

Table 3: Distribution of cases by patterns of pulmonary involvement and types of UC

Parameter	Total	Type of UC according to colonoscopy			*P* value
		Proctosigmoiditis	Left colitis	Pan-colitis	
Normal	17	5 (29.4%)	10 (58.8%)	2 (11.8%)	0.106
Restricted	5	0 (0%)	5 (100%)	0 (0%)	
Air retention	19	8 (42.1%)	10 (52.6%)	1 (5.3%)	
Obstruction plus Small airway obstruction	1	0 (0%)	0 (0%)	1 (100%)	
Obstruction plus air retention	5	1 (20%)	3 (60%)	1 (20%)	
Restricted plus small airway obstruction	1	0 (0%)	1 (100%)	0 (0%)	
Restricted plus air retention	3	1 (33.3%)	0 (0%)	2 (66.7%)	
Restricted plus airway resistance	1	1 (100%)	0 (0%)	0 (0%)	
Small airway obstruction plus Air retention	2	1 (50%)	1 (50%)	0 (0%)	
Obstruction plus small airway obstruction plus air retention	3	0 (0%)	2 (66.7%)	1 (33.3%)	
Restricted plus small airway obstruction plus air retention	2	0 (0%)	2 (100%)	0 (0%)	
Restricted plus small airway obstruction plus increased airway resistance	1	0 (0%)	1 (100%)	0 (0%)	
Restricted plus air retention plus increased airway resistance	1	0 (0%)	0 (0%)	1 (100%)	
Obstruction plus small airway obstruction plus air retention plus increased airway resistance	4	1 (25%)	3 (75%)	0 (0%)	

Table 4: The association between pulmonary parameters with the duration of disease (Pearson correlation analysis)

		FEV1	FVC	FEV1/FVC	RV	TLC	RV/TLC	FEF25-75	AWR
UC	PC	0.281 *	0.22	- 0.01	0.23	0.32 **	0.12	0.34 **	- 0.10
	Sig.	0.023	0.07	0.88	0.05	0.008	0.32	0.005	0.41
CD	PC	- 0.57	- 0.65 *	- 0.205	0.76 *	- 0.46	0.14	- 0.55	- 0.71 *
	Sig.	0.083	0.04	0.56	0.01	0.17	0.69	0.09	0.01

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
UC: Ulcerative colitis, CD: Crohn's disease, PC: Pearson correlation, Sig: Significant (2-tailed), FEV1: First second of forced expiration, FVC: Forced vital capacity, RV: Residual volume, TLC: Total lung capacity, FEF25-75: Forced expiratory flow between 25% and 75%, AWR: Airway resistance

have any clinical pulmonary symptoms. 10 patients (15.6%) suffered from cough, one patient (1.6%) from dyspnea alone and one patient (1.6%) from dyspnea plus cough. All of the patients with CD were without clinical pulmonary symptoms. The duration of UC in patients without clinical pulmonary symptoms was 42.54 ± 13.50 months and in patients with frequent cough was 48.10 ± 24.79 months. There was no significant relationship between the duration of UC with the clinical symptoms of respiratory disorders (p = 0.73). Information about pulmonary parameters in patients with UC who had or did not have clinical pulmonary symptoms is shown in table 5.

There were significant relationships between RV/TLC (p = 0.03) and FEF25-75% (p = 0.04) with the presence of clinical pulmonary symptoms in patients with UC.

Of 38 patients with left-sided colitis, 28 patients (73.68%) did not have clinical pulmonary symptoms, 8 patients (21.05%) suffered from cough alone, one patient (2.63%) from dyspnea alone, and also one patient (2.63%) from cough plus dyspnea. Seven out of the eight patients (87.5%) with pan-colitis had no clinical pulmonary symptoms and only one patient (12.5%) with this pattern of involvement of colon had cough alone. Of the 18 patients with

Table 5: The association between pulmonary parameters with clinical symptoms in patients with UC

Pulmonary parameters	Clinical pulmonary symptoms	Mean	*P* value
FEV1	Without symptoms	79.75 ± 13.78	0.386
	Cough	71.30 ± 23.37	
	Dyspnea	72	
	Cough + dyspnea	89	
FVC	Without symptoms	84.98 ± 10.68	0.978
	Cough	85.50 ± 16.56	
	Dyspnea	82	
	Cough + dyspnea	81	
FEV1/FVC	Without symptoms	77.42 ± 8.63	0.21
	Cough	71.60 ± 12.52	
	Dyspnea	71	
	Cough + dyspnea	86	
RV	Without symptoms	111 ± 24.73	0.624
	Cough	121.50 ± 17.85	
	Dyspnea	107	
	Cough + dyspnea	111	
TLC	Without symptoms	89.48 ± 11.46	0.707
	Cough	93.70 ± 13.67	
	Dyspnea	97	
	Cough + dyspnea	90	
RV/TLC	Without symptoms	36.21 ± 7.60	0.039
	Cough	50.20 ± 31.91	
	Dyspnea	27	
	Cough + dyspnea	43	
FEF25-75%	Without symptoms	68.96 ± 23.89	0.048
	Cough	52.10 ± 24.31	
	Dyspnea	58	
	Cough + dyspnea	115	
Airway resistance	Without symptoms	137.80 ± 52.63	0.468
	Cough	151.40 ± 41.81	
	Dyspnea	124	
	Cough + dyspnea	69	

UC: ulcerative colitis, FEV1: first second of forced expiration, FVC: forced vital capacity, RV: residual volume, TLC: total lung capacity, FEF25-75: forced expiratory flow between 25% and 75%

proctosigmoiditis, only one patient (5.6%) had cough alone and the remaining 17 patients (94.4%) had no clinical pulmonary symptoms. Statistical analysis shows that there was no significant relationship between clinical pulmonary symptoms with types of involvement of colon in patients with UC ($p = 0.6$). Nine

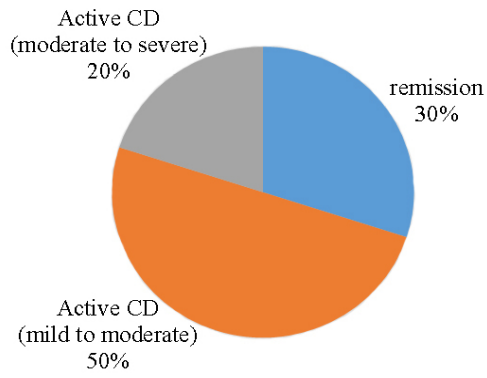

Fig.1: Distribution of patients with Ulcerative colitis according to the severity of the disease

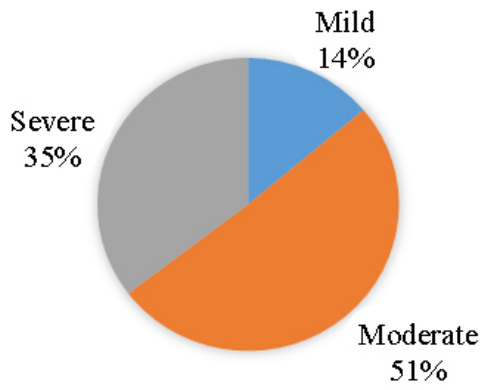

Fig.2: Distribution of patients with Crohn's disease according to the severity of the disease

patients (13.8%) were in mild, 33 patients (50.8%) in moderate, and 23 patients (35.4%) in the severe stages of UC (figure 1). Statistical analysis shows that there was no significant relationship between pulmonary parameters with severity of UC (table 6). Of 10 patients with CD, three patients (3%) had non-active CD, five patients (50%) had mild to moderate CD, and also two patients (20%) had moderate to severe CD (figure 2). In patients with CD, there were statistical relationships between FEV1, FVC, FEV1/FVC, RV, RV/TLC, FEF25-75% and increased airway resistance with severity of CD (table 7).

DISCUSSION

Pulmonary involvement is one the most important extra-intestinal symptoms of IBD. There are several pulmonary disorders such as chronic pneumonia, airway

Table 6: The association between pulmonary parameters with severity of UC

Parameters	Severity	Mean ± SD	*P* value
FEV1	Mild	78.22 ± 5.11	0.394
	Moderate	81.06 ± 16.67	
	Severe	75.26 ± 16.38	
FVC	Mild	82.66 ± 4.24	0.152
	Moderate	87.54 ± 12.56	
	Severe	81.82 ± 11.03	
FEV1/FVC	Mild	77.77 ± 3.27	0.443
	Moderate	77.81 ± 9.26	
	Severe	74.65 ± 11.13	
RV	Mild	98.55 ± 19	0.139
	Moderate	116.06 ± 24.11	
	Severe	112.52 ± 22.88	
TLC	Mild	84.44 ± 8.56	0.155
	Moderate	92.54 ± 12.98	
	Severe	89.21 ± 9.76	
RV/TLC	Mild	32.11 ± 6.05	0.373
	Moderate	39.9394	
	Severe	38.60 ± 9.78	
FEF25-75	Mild	59.77 ± 18.49	0.468
	Moderate	70.75 ± 23.86	
	Severe	65.52 ± 28.90	
Airway resistance	Mild	132.22 ± 35.46	0.780
	Moderate	135.27 ± 44.18	
	Severe	143.82 ± 64.78	

UC: Ulcerative colitis, SD: Standard deviation, FEV1: First second of forced expiration, FVC: Forced vital capacity, RV: Residual volume, TLC: Total lung capacity, FEF25-75%: Forced expiratory flow between 25% and 75%

Table 7: The association between pulmonary parameters with severity of CD

Parameters	Severity	Mean ± SD	*P* value
FEV1	remission	82	0.002
	Active CD (mild to moderate)	74 ± 5.47	
	Active CD (moderate to severe)	94	
FVC	remission	92	0.002
	Active CD (mild to moderate)	87.2 ± 4.38	
	Active CD (moderate to severe)	103	
FEV1/FVC	remission	76	0.000
	Active CD (mild to moderate)	68.8 ± 1.09	
	Active CD (moderate to severe)	79	
RV	remission	131	0.000
	Active CD (mild to moderate)	116.2 ± 1.64	
	Active CD (moderate to severe)	108	
TLC	remission	99	0.658
	Active CD (mild to moderate)	94.8 ± 9.31	
	Active CD (moderate to severe)	99	
RV/TLC	remission	31	0.0209
	Active CD (mild to moderate)	38.2 ± 6.57	
	Active CD (moderate to severe)	35	
FEF25-75	remission	61	0.015
	Active CD (mild to moderate)	47.4 ± 11.50	
	Active CD (moderate to severe)	76	
Airway resistance	remission	89	0.000
	Active CD (mild to moderate)	98 ± 2.73	
	Active CD (moderate to severe)	191	

CD: Crohn's disease, SD: Standard deviation, FEV1: First second of forced expiration, FVC: Forced vital capacity, RV: Residual volume, TLC: Total lung capacity, FEF25-75%: Forced expiratory flow between 25% and 75%

obstruction, organizing pneumonia, granulomatous disease, pulmonary vasculitis, pulmonary fibrosis, bronchiectasis, and pulmonary thromboembolism in patients with IBD (3-5). Opportunistic infections due to treatment with immunosuppressive drugs can be considered as important causes of pulmonary involvement in UC and CD (3-5). In patients with IBD, subclinical pulmonary abnormalities in pulmonary function tests (PFTs) can be detected in the remission and active phase of the disease (12-14). PFTs can be used for detecting early stages of pulmonary involvements. In the present study, we evaluated pulmonary parameters in PFTs, and also pattern of pulmonary involvement and their relationship with other variables such as the severity and the duration of UC and CD. Patients with UC and CD did not have a significant difference in terms of demographic characteristics such as age, sex, and body mass index. The mean age of the participants showed that the

third decade of life is the most common period of life for diagnosing UC or CD. A study conducted by Amra and colleagues suggested that the greater peak of clinical presentation of IBD is in the third decade of life (15). The most commonly used medications in our study were 5-aminosalicylic acid alone and then 5-aminosalicylic acid with corticosteroids. Goyal and colleagues reported that 5-aminosalicylic acid and steroids could be considered as widely used oral drug among their patients (16). The most prevalent types of involvement of gastrointestinal tract in patients with UC and CD in our study were left-sided colitis and ileocolitis, respectively. The hypothesis that perhaps pan-colitis, due to the wider extent of involvement of colon, is probably related to increased risk of further development of extra-intestinal symptoms is not acceptable. Our findings showed that pulmonary parameters in all types of UC including pan-colitis, proctosigmoiditis, and left-sided colitis were not statistically different. Our findings are consistent with the results of the study by Goyal and colleagues (16). They also stated that there were not any considerable significant differences of lung volumes and capacities between proctosigmoiditis, left-sided colitis, and pan-colitis (16).

A study was performed by Sharifpour and colleagues reported that FEV1 and FVC could be decreased significantly with increasing duration of UC (17). In a cross-sectional study that was conducted by Faghihi-Kashani and co-workers on 70 patients with confirmed diagnosis of UC, it was argued that there were considerable relationships between the duration of UC with absolute changes of RV and FEF25-75% (18). On the other hand, Yilmaz and others reported that the duration of IBD was not related to the PFT parameters (8). Despite the presence of controversies over the association between the duration of IBD and PFT parameters, our study showed that there were significant association between FEV1, TLC, and FEF25-75% with the duration of UC and also between FEV1, RV, and airway resistance with the duration of CD.

In our study, 81.3% of cases with UC had no clinical pulmonary symptoms. Ten patients with UC (15.6%) suffered from cough, one case from dyspnea alone and also one case from dyspnea plus cough. All of the patients with CD were without clinical pulmonary symptoms. Razzaghi and colleagues stated that 11 out of 29 patients enrolled to their study with UC and one out of eight patients with CD had pulmonary symptoms such as dyspnea, cough, and phlegm (19). According to our findings, there is no significant relationship between the duration of UC and clinical pulmonary symptoms. We also found that there was no considerable relationship between clinical pulmonary symptoms and types of involvement of colon in patients with UC.

There was abnormal spirometry in 73.44% and 30% of patients with UC and CD respectively. In the present study, there were air retention and small airway obstruction in 73.84% and 29.23% of patients with UC. In a study performed by Xiao-Qing Ji and colleagues, more than 50% of patients with IBD had abnormal spirometry pattern (20). A published paper by Ates and colleagues indicated that PFT abnormalities increased in the activation phases of UC and CD, and FVC, FEV1, RV/TLC, diffusing capacity of the lung for carbon monoxide, and diffusing capacity of the lung for carbon monoxide per liter alveolar volume values of the patients were considerably different in the activation and remission phases (21). We could not find a significant relationship between pulmonary parameters with severity of UC. However, in patients with CD, there were statistical relationships between FEV1, FVC, FEV1/FVC, RV, RV/TLC, FEF25-75% and increased airway resistance with severity and activation of CD. It is therefore understandable that there is an association between higher risk of pulmonary involvements and increased severity of illness in patients with CD but not in patients with UC.

Finally, we concluded that pulmonary involvements were found often in patients with IBD with and without the presence of clinical pulmonary symptoms. The duration and also activation and severity of IBD can be associated with increased risk of pulmonary involvements. Therefore, we strongly suggest that plethysmography and evaluation of pulmonary function by pulmonary parameters can be used as a non-invasive useful diagnostic modality for determining the activation and progression of IBD and can aid to the early diagnosis of the latent extra-intestinal involvements of IBD.

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CONFLICT OF INTEREST

The authors declare no conflict of interests related to this work.

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