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Assessment of Pulmonary Function Test (Pft) In Patients of Ankylosing Spondylitis

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Abstract: *Pulmonary involvement is a known manifestation of ankylosing spondylitis, emerging either as interstitial lung disease or as a consequence of chest wall abnormalities. Both of these conditions may lead to restrictive pulmonary function, typically presented as restrictive pattern in a pulmonary function test (spirometry). 50 patients of ankylosing spondylitis and 50 healthy individuals were recruited for the study. Pumonary function test showed that 15 (30%) patients of ankylosing spondylitis had pulmonary involvement. 11patients with restrictive ventilatory pattern and 4 with obstructive ventilatory pattern. A restrictive defect was manifested as a reduction of total lung capacity (TLC), as well as vital capacity (VC), and the pulmonary function test (PFT) was characterized by low forced vital capacity (FVC) and low forced expiratory flow in one second (FEV1) with normal or high FEV1/FVC ratio. Decreased forced expiratory volume in one second was associated with deteriorated functionality (p<0.05).*

Keywords: *Ankylosing spondylitis, pulmonary involvement, pulmonary function, pulmonary function test*

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I. Introduction

Ankylosing Spondylitis is a chronic, systemic, inflammatory, rheumatic disease affecting mainly the axial skeleton and sacroiliac joints, causing characteristic inflammatory back pain and resulting in varying degree of structural and functional impairments. It may also be associated with extra-spinal manifestations, involving peripheral joints, eye, skin, bowel and an increased risk of cardiovascular morbidity. Pulmonary involvement is a known manifestation of Ankylosing Spondylitis, emerging either as interstitial lung disease or as a consequence of chest wall abnormalities . Both of these conditions may lead to restrictive pulmonary function, typically presented as restrictive pattern in a pulmonary function test (spirometry). Ankylosing Spondylitis is characterized by inflammation in the thoracic vertebrae and in the costovertebral joints, causing gradual fusion and ossification of the joints, for some patients ultimately resulting in increased dorsal kyphosis, rigidity of the thorax and permanent chest wall immobility. Reduced lung volumes have been suggested to be a consequence of mechanical limitations, due to bony ankylosis of the thoracic joints, because restrictive respiratory impairment frequently has been reported to be associated with low thoracic expansibility. The stiff spondylitic thorax probably makes the main contribution to the impairment of lung function in patients of Ankylosing Spondylitis. Pulmonary function testing seems valuable even in patients with Ankylosing Spondylitis without lung symptoms and it might be used as a tool in staging of the disease, to evaluate treatment and to differentiate from fibrosis. [2,3]

The most typical respiratory abnormality seen in Ankylosing Spondylitis is a restrictive ventilatory defect. A restrictive defect is manifested as a reduction of total lung capacity (TLC), as well as vital capacity (VC), and the pulmonary function test (PFT) is characterized by low forced vital capacity (FVC) and low forced expiratory flow in one second (FEV1) with normal or high FEV1/FVC ratio. Usually, the abnormality in pulmonary function is mild. There are different opinions in the literature concerning the possible reasons for restrictive lung function in AS. Some favour mechanical causes due to bony ankylosis of the costovertebral and costotransverse joints resulting in chest wall rigidity, as restrictive pulmonary impairment in AS frequently is associated with a low thoracic expansibility . Others claim that ongoing inflammatory processes in the thoracic joints explain limitations of chest excursions, by causing pain and stiffness, and thus contributing to reduced pulmonary function. [5,6]

The thoracic rigidity may also lead to ventilatory disturbances with hyperinflation of the lung bases and severe hypoventilation of the apicies which in turn may lead to poor airway clearance, chronic inflammation and fibrosis. [7]

Others suggest that pleuropulmonary tissue is an independent primary target in AS, and that inflammatory processes in the lung parenchyma with tendency to fibrosis might be as significant as mechanical factors in the development of reduced pulmonary function in AS. [8]

Rosenow et al [9] , observed pleuropulmonary involvement in 28 (1.3%) of 2080 patients with AS. Interstitial lung disease (ILD) influences both the arterial blood gases and the lung mechanics, and is, like chest wall restriction, typically manifested in PFT as a restrictive pattern. In a cross-sectional study, 147 patients with AS underwent pulmonary function test (PFT). AS patients showed significantly lower PFT values compared with the controls; forced vital capacity (FVC%) (97% vs 105%, p<0.001), forced expiratory volume in 1 sec (FEV1%) (90% vs 99%, p<0.001) and peak expiratory flow (PEF%) (95% vs 99%, p=0.05). Significantly more patients than controls were categorized with a restrictive respiratory pattern (18% vs 0%, p<0.001). This study showed significantly reduced pulmonary function in AS patients. Restrictive ventilatory impairment was found in 18% of the patients. [10]

Gunnhild, Silje, Morten et al [11] , in a cross-sectional study of patients clinically diagnosed with Ankylosing Spondylitis by a rheumatologist and aged between 18 and 70 years were recruited from a hospital-based register. Additionally, 121 population controls were randomly selected from the national register by Statistics Norway to match age, gender and residential area of the Ankylosing Spondylitis patients. The only exclusion criterion was a history of inflammatory arthritis. This study showed that patients with Ankylosing Spondylitis were more likely to have restrictive respiratory impairment compared to controls and reference data. The reduced pulmonary function was closely related to reduced spinal and chest wall mobility. N Feltelius et al [12] , in a study of thirty two patients with Ankylosing Spondylitis were investigated with a set of pulmonary function tests and results compared with those for a control population. The patients had no complaints about lung symptoms and their chest radiographs were normal. The main pathological findings were reduced lung volumes, a raised closing volume/vital capacity ratio, and a decreased volumic airway conductance. The lung volume reduction correlated with disease duration, thoracic mobility, and degree of acute phase reaction. The stiff spondylitic thorax probably makes the main contribution to the impairment of lung function in these patients. There are different opinions in the literature concerning the possible reasons for restrictive lung function in AS. Some favour mechanical causes due to bony ankylosis of the costovertebral and costotransverse joints resulting in chest wall rigidity as restrictive pulmonary impairment in AS frequently is associated with a low thoracic expansibility [13,14].

Others claim that ongoing inflammatory processes in the thoracic joints explain limitations of chest excursions, by causing pain and stiffness, and thus contributing to reduced pulmonary function [15,16] . Others suggest that pleuropulmonary tissue is an independent primary target in AS, and that inflammatory processes in the lung parenchyma with tendency to fibrosis might be as significant as mechanical factors in the development of reduced pulmonary function in AS [15,16,17.]

II. Materials And Methods

This study was a case control study including 50 cases of ankylosing spondylitis and 50 age and sex matched controls. All Patients having signs and symptoms of Ankylosing Spondylitis were subjected to pulmonary function test. Patients qualifying by fulfilling all inclusion criteria and exclusion criteria were enlisted in study after informed consent. Exclusion criteria were patients who were older than 50 or younger than 18 years, or who have heart diseases, hypertension, diabetes mellitus, pulmonary, neoplastic or other chronic diseases. Spirometry was done to measure airflow. In a spirometry test, patient was made to sit and was directed to breathe into a mouthpiece that is connected to an instrument called a spirometer. The spirometer recorded the amount and the rate of air that the patient breathed in and out over a period of time. The main pathological findings were reduced lung volumes, a raised closing volume/vital capacity ratio, and a decreased volumic airway conductance. The stiff spondylitic thorax probably makes the main contribution to the impairment of lung function in these patients.

1.FVC- Forced Vital Capacity: the maximal volume of air delivered during an expiration made as forcefully and completely as possible starting from full inspiration; that is, vital capacity performed with a maximally forced expiratory effort, expressed in liters.
2.FEV_1 - Forced Expiratory Volume in one second: the volume, expressed in liters, delivered in the first second of the FVC manoeuvre.
3.Restrictive ventilatory pattern (FVC $\leq$ 80%, $FEV_1/FVC \geq 70\%$, decreased or normal FEV_1), obstructive ventilatory pattern ($FEV_1/FVC < 70\%$, decreased FEV_1, normal or decreased FVC) or normal pulmonary function (FVC > 80%, FEV_1 > 80%, $FEV_1/FVC > 80\%$)

III. Results

This study was a case control study done with the aim to estimate Pulmonary function in Patients of Ankylosing spondylitis. The study sample comprised of 50 patients already diagnosed as patients of Ankylosing spondylitis who were seen as out patient department and study was conducted after taking informed consent from patient and family over a period of 2014 to 2016. 50 controls from a healthy population were also taken during the same period. The results of the study are compiled and analysed using various statistical tools.

Table 1. Age distribution

Age	No of Patients	Percentage	No of Controls	Percentage
20-30 years	34	68%	35	70%
31-40 years	11	22%	12	24%
41-50 years	5	10%	3	6%
Total	50		50	

The majority of the study population, 68% was in the 20-30 year age group at presentation. 22% of patients belonged to the 30-40 year age group whereas 10% of patients comprised the 40-50 year age group. The age distribution in controls was nearly equal to the cases.

Table 2. Sex Distribution among different age groups in cases

Age Group	Cases		Controls	
	Male	Female	Male	Female
20-30 years	16	10	18	11
31-40 years	10	05	12	03
41-50 years	06	03	06	03

Table 2 represents the sex ratio in different age groups in case and control group. In the case group, there were 16 males and 10 females in the age group of 20-30 years,10 males and 5 females in the age group of 31-40 years,6 males and 3 females in the age group of 41-50 years. In the control group there were 18 males and 11 females in the age group of 20-30 years, there were 12 males and 3 females in the age group 31-40 years, 6 males and 3 females in the age group 41-50 years.

Results of Pulmonary Function Test in male patients of AS versus male controls.

Table 4 (a) showing interpretation of pulmonary function in male patients of AS versus male controls

Spirometry	Male cases n=32	Male controls n=36	P value
FVC % (SD)(range)	94.1 (17.7) (53-136)	100.3 (14.0) (62-130)	0.02
FEV1 %	89.1 (16.7) (52-126)	98.3 (15.3) (57-136)	<0.001
PEF %	95.7 (18.6) (48-135)	101.9 (18) (41-136)	0.04
FEV1/FVC %	76.6 (6.7) (61-93)	78.4 (6.3) (59-93)	0.096
Interpretation of PFT	Male cases n=32	Male controls n=36	p- value
Normal (n) (%)	22 (69.0)	34 (94.0)	0.001
Restrictive pattern (n) (%)	8 (25)	0	0<0.001
Obstructive pattern (n) (%)	2 (6.25)	2 (5.6)	1.000

Results of Pulmonary Function Test in female patients of AS versus female controls.

Table 4 (b) showing results of pulmonary function test in female patients of AS versus female controls

Spirometry	Female cases n=18	Female controls n=14	P value
FVC % (SD)(range)	102.4 (17.9) (64-140)	110.9 (14.7) (71-138)	0.008
FEV1 %	90.9 (14.9) (61-121)	98.8 (13.5) (66-127)	0.005
PEF %	94.2 (15.8) (58-124)	96.2 (14.1) (69-130)	0.483
FEV1/FVC %	76.1 (8.8) (54-99)	75.7 (6.2) (60-90)	0.770
Interpretation of PFT	Female cases n=18	Female controls n=14	p- value
Normal (n) (%)	13 (72.0)	12(85.7%)	0.050
Restrictive pattern (n) (%)	3 (16.7)	0	0.03
Obstructive pattern (n) (%)	(11.2)	2 (14.3)	0.579

Table 4 (a) and Table 4 (b) shows comparisons of PFT scores between AS patients and controls of same gender which showed significant differences for males in all PFT parameters; FVC% (p=0.02), FEV1% (p<0.001), and

PEF% (p=0.04), except for the FEV1/FVC% ratio, indicating a weaker pulmonary condition (not obstructive) in male AS patients compared to male controls. The proportion of restrictive ventilatory pattern was significantly higher (p<0.001) in male AS patients (n=08) compared to male controls (n=0). For females the comparisons of same gender showed significant differences in FVC% (p=0.008) and in FEV1% (p=0.005) scores. 3 female AS patients presented a restrictive ventilatory pattern compared to 0 in the control group, and this difference was significant (p=0.03). There were no significant differences in the occurence of obstructive ventilatory pattern between patients and controls of same gender.

Graph showing results of Pulmonary function test in patients of AS

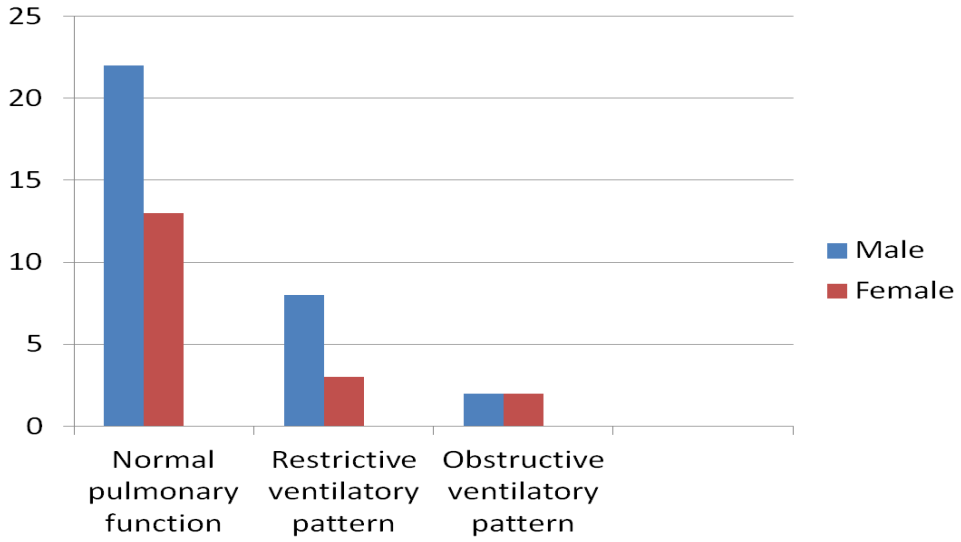
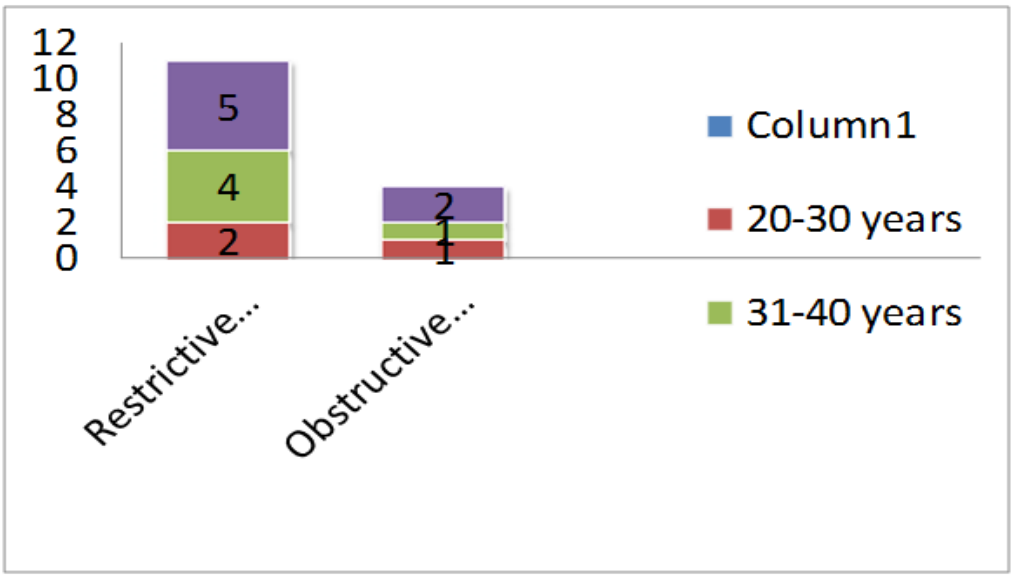


Table 4 (c): showing age wise interpretation of Pulomonary Function Test in patients of AS

Age	AS patients with Restrictive ventilatory Pattern	AS patients with Obstructive ventilatory Pattern
20-30 years	2	1
31-40 years	4	1
41-50 years	5	2

Table 4 (c) shows age wise interpretation of pulmonary function in patients of AS. Out of 11 patients with restrictive ventilator pattern 2 were of the age group 20-30 years, 4 were of the age 31-40 years and 5 were of the age group 41- 50 years. Out of 4 patients with obstructive ventilator pattern 1 was of the age group 20-30 years, 1 was of the age group 31-40 years and 2 was from the age group 41-50 years.

Graphical representation of age wise interpretation of Pulmonary Function in patients of AS



IV. Discussion

The present study was conducted in 50 patients seen in outpatient department of Medicine with a diagnosis of Anylosing Spondylitis. 50 controls from healthy population were also included for the study. 2-D Echo and Pulmonary function test were done apart from other investigations to assess Pulmonary function and ventricular dysfunction in these patients. Pulmonary function tests in patients of Anylosing Spondylitis showed that PFT scores between AS patients and controls of same gender showed significant differences for males in all PFT parameters; FVC% ($p=0.02$), FEV1% ($p<0.001$), and PEF% ($p=0.04$), except for the FEV1/FVC% ratio, indicating a weaker pulmonary condition (not obstructive) in male AS patients compared to male controls. The proportion of restrictive ventilatory pattern was significantly higher ($p<0.001$) in male AS patients (n=08) compared to male controls (n=0). For females the comparisons of same gender showed significant differences in FVC% ($p=0.008$) and in FEV1% ($p=0.005$) scores. 3 female AS patients presented a restrictive ventilatory pattern compared to 0 in the control group, and this difference was significant ($p=0.03$). There were no significant differences in the occurence of obstructive ventilatory pattern between patients and controls of same gender. In a study by Sieper J, Braun J et al [18] , PFT exposed significantly lower values for the AS patients compared to the controls with regard to FVC% (97 vs105, $p<0.001$), FEV1% (90 vs 99, $p<0.001$), and PEF% (95 vs 99, $p=0.05$). Most of the AS patients were categorized with normal pulmonary function, but 18 % (n=27) were categorized with restrictive pattern. As none of the population controls showed a restrictive pattern, the proportion of pulmonary impairment in the two groups was significantly different ($p<0.001$).

Gunnhild, Silje, Morten et al [11], in a study of patients clinically diagnosed with Ankylosing Spondylitis by a rheumatologist and aged between 18 and 70 years were recruited from a hospital-based register. Additionally, 121 population controls were randomly selected from the national register by Statistics Norway to match age, gender and residential area of the Ankylosing Spondylitis patients. The only exclusion criterion was a history of inflammatory arthritis. This study showed that patients with Ankylosing Spondylitis were more likely to have restrictive respiratory impairment compared to controls and reference data. The reduced pulmonary function was closely related to reduced spinal and chest wall mobility. N Feltelius et al [12] , in a study of thirty two patients with Ankylosing Spondylitis were investigated with a set of pulmonary function tests and results compared with those for a control population. The patients had no complaints about lung symptoms and their chest radiographs were normal. The main pathological findings were reduced lung volumes, a raised closing volume/vital capacity ratio, and a decreased volumic airway conductance. The lung volume reduction correlated with disease duration, thoracic mobility, and degree of acute phase reaction. The stiff spondylitic thorax probably makes the main contribution to the impairment of lung function in these patients. This type of pulmonary function testing seems valuable even in patients with Ankylosing Spondylitis without lung symptoms and it might be used as a tool in staging of the disease, to evaluate treatment and to differentiate from fibrosis.

V. Conclusion

The results in the present study support the theory of mechanical, rather than inflammatory, causes responsible for restrictive pulmonary impairment in Anylosing Spondylitis. Reduced spinal- and chest wall mobility was strongly and significantly associated with restrictive impairment. 85 % of the patients with restrictive ventilatory impairment were not aware of having a pulmonary disease. This finding makes visible a need for patient education, or for empowering patients with decision knowledge. Knowledge is an important factor concerning the ability to manage, or limit, the consequences of chronic disease. On the other hand, the finding may also indicate that the patients with restrictive impairment were not severely afflicted by it. Thus, the problem may be less relevant to the clinical situation. However, patients with severely reduced spinal- or chest wall mobility should be referred to examinations of pulmonary function and relevant follow-up treatment.

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