Section: Miscellaneous

Original Research Article

STUDY ON PULMONARY MANIFESTATIONS IN ANKYLOSING SPONDYLITIS

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ABSTRACT

Background: Ankylosing spondylitis (AS) is a chronic inflammatory disorder primarily affecting the axial skeleton and is associated with extra-articular manifestations, including pulmonary involvement. This study aimed to evaluate the prevalence of pulmonary manifestations in AS and assess their association with pulmonary function test (PFT) abnormalities, high-resolution computed tomography (HRCT) findings, age, and disease duration. **Materials and Methods:** This prospective observational study included 50 patients aged 18–60 years fulfilling the ASAS criteria for AS at a tertiary care centre between July 2014 and July 2015. Clinical evaluation, laboratory investigations, chest radiography, HRCT thorax, and spirometry were performed. Statistical analysis was conducted using SPSS v25, with $p<0.05$ considered significant. **Result:** The study included 80% males, with a mean age of 38.29 ± 3.4 years. Pulmonary manifestations were identified in 20% of patients. Affected individuals were significantly older (40.82 ± 2.68 vs 37.98 ± 3.36 years; $p<0.01$) and had longer disease duration (10.7 ± 1.16 vs 4.55 ± 1.95 years; $p<0.001$). No patients with disease duration <5 years showed pulmonary involvement. HRCT detected interstitial lung disease in 40% of affected patients ($p<0.01$), while chest radiography demonstrated apical fibrosis in 20% ($p<0.05$). All patients with pulmonary manifestations exhibited restrictive defects on PFTs (60% mild, 40% moderate; $p<0.01$). No significant association was observed with sex or CRP levels. **Conclusion:** Pulmonary involvement in AS is significantly associated with advancing age and prolonged disease duration. HRCT and spirometry are superior to conventional radiography in detecting early pulmonary changes. Routine respiratory screening, particularly in long-standing disease, may facilitate early intervention and improved clinical outcomes.

INTRODUCTION

Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease primarily affecting the axial skeleton, including the spine and sacroiliac joints, leading to progressive stiffness and potential fusion of vertebral segments. This condition comes under the axial spondyloarthritis (axSpA) and usually manifests in young adults, with a higher incidence in males, though recent data suggest underdiagnosis in females.[1] The global prevalence of AS varies by population, ranging from 0.1% to 1.4%, influenced by genetic factors such as HLA-B27 positivity, which is present in up to 90% of affected individuals. Beyond skeletal involvement, AS is characterised by extra-articular manifestations that can significantly impact quality of life and require multidisciplinary management.[2]

Pulmonary involvement is one of the main extra-articular features of AS, often arising from mechanical restrictions due to thoracic spine rigidity, ossification of costovertebral joints, and reduced chest wall expansion.[3] These changes commonly result in a restrictive ventilatory pattern on pulmonary function tests (PFTs), with reduced forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), even in the absence of overt radiological abnormalities.[4] Studies indicate that the prevalence of restrictive lung disease in AS patients ranges from 20% to 57%, frequently remaining asymptomatic in early stages but correlating with disease duration and severity.[3] The subclinical diaphragm dysfunction, assessed via ultrasound, has been associated with impaired axial mobility and lower FVC values.[5,6]

Radiological findings, such as those from high-resolution computed tomography (HRCT), reveal a heterogeneous spectrum of pulmonary abnormalities in AS, including apical fibrobullous disease, interstitial changes, and emphysema, with reported

prevalence rates varying widely from 0% to 85% across cohorts.[7,8] A large-scale analysis from the UK Biobank noted a low overall prevalence of imaging-detected pulmonary issues at 1.3% in spondyloarthritis groups, predominantly in AS subsets.[7] There is an increased risk of vascular complications such as pulmonary embolism (PE) in patients with AS, related to chronic systemic inflammation.[9] This variability in manifestations emphasises the importance of correlating pulmonary lesions with AS progression metrics, such as disease activity scores and duration, to guide timely interventions.[10,11]

Even though biologic therapies reduce some inflammatory causes, pulmonary complications persist and result in morbidity, leading to reduced exercise tolerance and increased infection risk.[3] Early detection through PFTs, HRCT, and novel modalities like diaphragmatic ultrasound could improve outcomes by identifying at-risk patients before irreversible damage occurs.[5] However, there are still gaps in understanding the precise mechanisms linking AS severity to lung pathology, particularly in diverse populations. Hence, this study aims to analyse the prevalence of pulmonary manifestations in AS patients. To observe changes via PFTs and HRCT, investigate correlations with underlying AS-related pulmonary manifestations, and explore relationships between lesion characteristics, disease severity, and duration.

MATERIALS AND METHODS

This prospective observational study was conducted on 50 patients with AS attending the outpatient departments of Medicine and Rheumatology at Coimbatore Medical College Hospital, Coimbatore, from July 2014 to July 2015. The study was performed after obtaining clearance from the Institutional Ethics Committee. Informed consent was obtained from all patients before enrolling in the study.

Inclusion Criteria

Adult patients (both sexes) aged between 18 and 60 years who satisfied the Assessment of Ankylosing Spondylitis International Society (ASAS) criteria for AS.

Exclusion Criteria

Pregnant women, minors (below the age of consent), persons suffering from other interstitial lung diseases, pulmonary tuberculosis, other obstructive and restrictive lung diseases, pleural diseases, psoriatic arthritis, persons not capable of giving consent (e.g., psychiatric patients), and persons unwilling to undergo the study (who refused consent).

Methods: Patients were diagnosed with AS according to the ASAS criteria, which apply to individuals with chronic low back pain lasting >three months and an age at onset <45 years. Diagnosis was made by the presence of either imaging evidence of sacroiliitis plus at least one clinical parameter, or HLA-B27 positivity along with at least two clinical parameters. Imaging criteria included radiographic sacroiliitis graded as bilateral grade 2 or unilateral grade 3–4 according to the modified New York criteria (1984), or evidence of active sacroiliac joint inflammation on magnetic resonance imaging. Clinical parameters comprised arthritis, enthesitis, uveitis, psoriasis, inflammatory bowel disease (Crohn's disease or ulcerative colitis), inflammatory back pain, good response to non-steroidal anti-inflammatory drugs, positive family history of spondyloarthritis, and elevated C-reactive protein levels. A detailed clinical history was obtained from all patients, followed by thorough physical examination, with specific emphasis on respiratory symptoms and signs of pulmonary involvement.

Laboratory investigations included complete haemogram, differential leukocyte count, erythrocyte sedimentation rate, C-reactive protein, renal function tests, liver function tests, and serum lipid profile. Radiological evaluation comprised chest radiography and HRCT of the thorax. PFT was performed in all patients using spirometry with the subject in an upright position and wearing a nose clip; patients were instructed to avoid alcohol intake, vigorous exercise, tight clothing, and heavy meals prior to testing. Spirometric parameters measured included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow (PEF), and the FEV1/FVC ratio. Pulmonary function patterns were classified as restrictive (FVC <80% predicted with FEV1/FVC >70% and normal or reduced FEV1), obstructive (FEV1/FVC <70% with reduced FEV1), or normal (FVC >80%, FEV1 >80%, and FEV1/FVC >80%). The severity of restrictive ventilatory defect was graded based on FVC percentage predicted as mild (60–80%), moderate (45–60%), or severe (<45%). HRCT images were evaluated for pulmonary parenchymal abnormalities, including interstitial lung involvement, usual interstitial pneumonia patterns, and honeycombing, which are recognised pulmonary manifestations of AS. Patients were categorised based on the presence or absence of pulmonary manifestations for analytical comparison.

Statistical Analysis: Data were reported as mean ± standard deviation (SD) or median, depending on distribution. Differences in quantitative variables between groups were assessed using the unpaired t-test. Continuous variables were compared using the independent sample t-test or Mann–Whitney U test, as appropriate. Categorical variables were analysed using the Chi-square test or Fisher's exact test. A p-value <0.05 (two-tailed) was considered statistically significant. All data were analysed using SPSS v.25.

RESULTS

Among the 50 patients, 80% were male and 20% female. The majority were aged 36–40 years (50%), followed by 41–45 years (26%) and 31–35 years (24%). The mean age was 38.29 ± 3.4 years (males:

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38.63 ± 3.44; females: 37.21 ± 3.18; p > 0.05). Disease duration was <5 years in 52%, 5–10 years in 38%, and pulmonary manifestations were present in 20% of patients [Table 1].

Table 1: Demographic Profile, Disease Duration, and Prevalence of Pulmonary Manifestations

Category	Variable	Values
Sex	Male	40 (80%)
	Female	10 (20%)
Age Group (years)	31–35	12 (24%)
	36–40	25 (50%)
	41–45	13 (26%)
	>45	0
Mean age (years)	Male	38.63 ± 3.44
	Female	37.21 ± 3.18
Duration of Disease (years)	< 5	26 (52%)
	5–10	19 (38%)
	> 10	5 (10%)
Pulmonary manifestation	With	10 (20%)
	Without	40 (80%)

Patients with pulmonary involvement were older (40.82 ± 2.68 vs 37.98 ± 3.36 years, p<0.01), with most cases in the 41–45 years group (60%, p<0.05). No patients with duration <5 years had pulmonary involvement, whereas 50% each were in the 5–10 and >10 year groups. Mean disease duration was significantly higher in those with pulmonary manifestations (10.7 ± 1.16 vs 4.55 ± 1.95 years, p<0.001). Pulmonary symptoms were present in 60% of patients with pulmonary manifestations (p<0.05). Sex distribution, number of positive clinical parameters, and CRP levels showed no significant association (p>0.05) [Table 2].

Table 2: Association Between Clinical Variables and Pulmonary Manifestations

Parameters		Pulmonary Manifestations		p-value
		With	Without	
Sex	Male	7 (70%)	33 (82.5%)	>0.05
	Female	3 (30%)	7 (17.5%)	
Pulmonary Symptoms	Yes	6 (60%)	0	<0.05
	No	4 (40%)	40 (100%)	
Age Group (years)	31–35	1 (10%)	11 (27.5%)	<0.05
	36–40	3 (30%)	22 (55%)	
	41–45	6 (60%)	7 (17.5%)	
	>45	0	0	
Mean Age (years)		40.82 ± 2.68	37.98 ± 3.36	<0.01
Duration of Disease (years)	< 5	0	26 (65%)	<0.001
	5–10	5 (50%)	14 (35%)	
	> 10	5 (50%)	0	
Mean Duration (years)		10.7 ± 1.16	4.55 ± 1.95	<0.001
No. of Positive Clinical Parameters	2	1 (10%)	13 (32.5%)	>0.05
	3	7 (70%)	20 (50%)	
	4	2 (20%)	7 (17.5%)	
CRP (mg/L)		13 ± 5.72	11.54 ± 6.76	>0.05

X-ray grading showed no significant association with pulmonary manifestations (p > 0.05). Chest X-ray showed apical fibrosis in 20% of patients with pulmonary manifestations, while none without pulmonary involvement had abnormal findings (p<0.05). HRCT detected ILD in 40% of patients with pulmonary manifestations (p<0.01). PFT abnormalities were present in all patients with pulmonary manifestations, with 60% showing mild and 40% moderate impairment (p<0.01) [Table 3].

Table 3: Radiological and Functional Associations of Pulmonary Manifestations

Parameter	Category	Pulmonary Manifestation		p-value
		With	Without	
X-ray Imaging Grade	2 B/L	2 (20%)	10 (25%)	>0.05
	3 U/L	5 (50%)	15 (37.5%)	
	3 B/L	2 (20%)	5 (12.5%)	
	4 U/L	0	9 (22.5%)	
	4 B/L	1 (10%)	1 (2.5%)	
Chest X-ray Finding	Apical fibrosis	2 (20%)	0	<0.05
	Normal	8 (80%)	40 (100%)	
HRCT Chest	ILD	4 (40%)	0	<0.01
	Normal	6 (60%)	40 (100%)	
PFT	Mild	6 (60%)	0	<0.01
	Moderate	4 (40%)	0	
	Normal	0	40 (100%)	

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DISCUSSION

AS is a chronic inflammatory disorder with well-recognised axial skeletal involvement. This study evaluated the prevalence and pattern of pulmonary manifestations in patients with AS and assessed their association with PFT abnormalities, HRCT findings, age, and disease duration. The findings show that pulmonary involvement was significantly associated with older age and longer disease duration. Conventional chest radiography showed limited sensitivity, whereas HRCT and spirometry performed better in detecting early pulmonary changes.

The study population was predominantly male, with most participants in the middle-aged groups. The overall mean age of the study population showed no significant difference between males and females. Similarly, Berdal et al. reported male predominance in AS patients (approximately 63% males) in a larger cohort of 147 patients and 121 controls, although their population was older.[11] These findings indicate a consistent male predominance in AS across studies, even though there are differences in age distribution.

In our study, pulmonary symptoms showed a significant association with pulmonary manifestations among patients. Similarly, Ibrahim et al. reported frequent HRCT-detected pulmonary involvement in AS, even among asymptomatic patients. In their study of 30 patients, 90% showed positive HRCT findings. The pulmonary involvement was more with increasing disease duration.[12] These findings indicate that pulmonary involvement in AS may be subclinical and more effectively detected by HRCT than by clinical symptoms.

Based on our findings, pulmonary manifestations showed a significant association with increasing age, with higher occurrence in older age groups. Similarly, Zhou et al. reported a mean age of 40.0 ± 9.4 years, with 56 out of 79 cases (approximately 71%) showing impaired pulmonary function associated with reduced lung volume and height on 3D thoracic CT and PFTs. No significant age difference was observed between patients with normal and impaired pulmonary function ($p = 0.340$).[13] These findings suggest that while pulmonary involvement in AS is common and often related to disease severity, the age-related pattern may vary depending on the method of detection and study characteristics.

In our study, pulmonary manifestations showed a significant association with increased duration of disease, while no significant association was observed with clinical parameters. Similarly, Ibrahim et al. found HRCT abnormalities in 90% (27/30) of AS patients, more prominent in ≥10 years duration (13/13 abnormal) vs. <10 years (14/17, often milder), with no BASDAI correlation (p=0.5).12 Ozdemir et al. observed HRCT abnormalities in 70% (14/20) of AS patients, significantly more prominent in patients with≥10 years' duration (p=0.015), mainly apical fibrosis (45%) and emphysema (25%).[14] These studies support that pulmonary manifestations in AS tend to be absent in short-duration disease but increase with longer duration.

In our study, conventional X-ray grading showed no significant association with pulmonary manifestations, whereas apical fibrosis on chest X-ray was significantly associated. In contrast, HRCT demonstrated a strong association with interstitial lung involvement. Similarly, El Maghraoui et al. found plain chest X-ray abnormalities in only 2/55 (4%) AS patients, with no correlation to structural severity, while HRCT detected abnormalities in 52.7% (29/55), including ILD (n=4, 7%) and apical fibrosis (n=5, 9%). Apical fibrosis was significantly associated with longer duration (p=0.0029), whereas HRCT findings showed no broad association with symptomatic severity.[15] This is similar to our findings, where conventional X-ray grading did not show a significant association with pulmonary involvement, whereas HRCT demonstrated superior sensitivity in detecting interstitial lung disease. Therefore, HRCT should be considered, particularly in patients with longer disease duration.

In our study, all patients with pulmonary manifestations demonstrated abnormal PFT findings, while those without pulmonary involvement had normal results. This association between pulmonary manifestations and pulmonary function abnormalities was significant. Similarly, Zhou et al. reported that all AS patients with pulmonary function impairment 71% had abnormal PFT showing a restrictive pattern with reduced lung volume and height, whereas the remaining 19 patients with normal pulmonary function showed no impairment.[13] This is also supported by Berdal et al., who found restrictive pulmonary function abnormality in 18% of AS patients (27/147), while the majority without a restrictive pattern had normal pulmonary function ($p < 0.001$).[11] PFT serves as a reliable and objective tool for detecting and monitoring pulmonary involvement in AS. Pulmonary manifestations in AS show a strong association with abnormal PFTs.

In our study, patients with pulmonary manifestations were characterised by higher age and longer disease duration compared to those without pulmonary involvement. In contrast, inflammatory marker levels did not show a significant association with pulmonary manifestations. Berdal et al. found restrictive pulmonary function more prevalent in AS patients (18% vs. 0% in controls, $p < 0.001$), associated with longer disease duration ($p = 0.054$ borderline) and older age, while CRP levels were higher in the restrictive group (median 7.0 vs. 3.0 mg/L) but not significant ($p = 0.063$), and ESR was significant ($p = 0.006$).[11] Similarly, the systematic review by El Maghraoui and Dehhaoui involving 303 patients reported HRCT abnormalities in 61% of cases, with upper lobe fibrosis increasing significantly with longer disease duration ($p = 0.049$). Mild, nonspecific interstitial changes were common even in early and asymptomatic disease, with no

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association with disease severity or smoking.[15] Thus, older patients and those with longer disease duration should be actively screened for pulmonary involvement regardless of inflammatory marker levels.

Limitations: The relatively small sample size and single-centre design may limit the generalizability of the findings to broader populations. Total lung capacity measurements were not performed, which may have led to an underestimation of true restrictive ventilatory defects. Disease activity indices such as BASDAI and spinal mobility scores were not systematically evaluated, limiting correlation with pulmonary findings.

CONCLUSION

Pulmonary involvement was significantly associated with increasing age and longer disease duration, while no relationship was observed with gender or inflammatory markers such as CRP. PFT showed a predominantly restrictive pattern in patients with pulmonary manifestations, whereas HRCT proved superior to conventional chest radiography in detecting subclinical interstitial lung disease. Routine respiratory evaluation, particularly in patients with long-standing disease, may enable timely intervention and improve overall disease management.

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