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Occurrence of bronchial anthracofibrosis in respiratory symptomatics with exposure to biomass fuel smoke

The authors declare no financial disclosure

Abstract

Introduction: Bronchial anthracofibrosis (BAF), confirmed bronchoscopically, is characterised by bluish-black mucosal pigmentation and distortion/narrowing of the bronchus. We investigated the occurrence of BAF in respiratory symptomatics with biomass fuel smoke exposure and evaluated its clinico-radiological attributes and impact on functional status.

Material and methods: Of the eighty subjects evaluated, 60 consented for fiberoptic bronchoscopy (FOB). All 60 subjects also underwent chest radiography, high resolution computed tomography (HRCT) of the thorax, spirometry with reversibility testing and six-minute-walk test. Information regarding cardinal respiratory symptoms and duration of biomass fuel smoke exposure was documented. FOB evaluation revealed that 24 patients had BAF (Group 1), 17 had bronchial anthracosis (Group 2) and 19 had normal appearance (Group 3).

Results: Group 1 patients had significantly higher biomass fuel smoke exposure ($p < 0.0001$) and lower walk distance ($p = 0.003$) with greater desaturation. On HRCT, segmental collapse and consolidation were significantly higher in Group 1 while fibrotic lesions were the predominantly seen in Groups 2 and 3. A significant inverse correlation in Group 1 was seen between exposure index, six-minute-walk distance and spirometric parameters. In Group 1, the right middle lobe (RML) bronchus was most commonly involved (15/24 [62.5%]). In Group 2, RML and left upper lobe bronchi were affected in 8/17 (47.1%) patients each.

Conclusions: All patients in our study were females. Those with BAF had poorer functional status as compared to those with anthracosis only. On imaging, multifocal bronchial narrowing was specific to BAF.

Key words: anthracosis; biomass fuel smoke; bronchial anthracofibrosis; fiberoptic bronchoscopy; high resolution computed tomography of the thorax

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Introduction

Pearson [1] coined the term "Anthracosis" in 1813 to highlight the bluish-black discolouration of the bronchial mucosa caused by inhalation of soot. This phenomenon was frequently seen in coal workers, cigarette smokers and city dwellers. Endobronchial pigmentation with airway narrowing was first described in 1951 by Abraham Cohen [2] when he described middle lobe narrowing in eight female patients due to perforated tuberculous lymph nodes. Six of these eight patients had anthracotic pigmentation in the right middle lobe. This would seem to be the first ever description of "bronchial anthracofibrosis (BAF)", a term first coined by Chung *et al.* [3] from Korea. They described bronchoscopically visible anthracotic pigmentation with narrowing/distortion of the bronchi in 20/28 elderly subjects with significant wood smoke exposure. They portrayed the clinical peculiarity of the disease and highlighted that the right middle lobe was most commonly involved and was associated with active tuberculosis in 61%. The authors even favoured expeditious initiation of anti-tuberculous therapy as they postulated that BAF was caused

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by "fibrotic response to active or old tuberculous infection". However, a mounting body of evidence has emerged to impute long standing biomass fuel smoke exposure as major incriminating factor [4].

It is currently estimated that nearly half the world's population, especially in the developing countries, is dependent on biomass fuel such as wood, charcoal, animal dung for cooking and heating their homes [5]. Indoor combustion of biomass solid fuels has been identified by the World Health Organization as the fourth leading risk factor for disease burden worldwide [6]. Incomplete combustion of these fuels is the source of smoke containing approximately 200 compounds of gaseous pollutants along with solid particulate matter. Cooking is frequently done in poorly ventilated areas with kitchen being combined with the living area. Blackish soot deposition is frequently seen lining the ceilings and walls in these areas [4].

BAF was first reported from India in a 65-year -old female with longstanding history of wood smoke exposure who presented with a middle lobe syndrome (MLS) [7]. Fibrebronchoscopy confirmed the presence of anthracotic pigmentation with narrowing of the right middle lobe bronchus and *Mycobacterium tuberculosis* was cultured from bronchial aspirate. With increasing awareness of BAF in our country, we attempted to ascertain the occurrence of BAF and anthracosis in respiratory symptomatics with long standing history of biomass fuel smoke exposure. In addition, the study endeavours to determine the clinical, spirometric, imaging and bronchoscopic characteristics of BAF and anthracosis.

Material and methods

Study population

Newly referred respiratory symptomatics, 40 years and above, with history of exposure to biomass fuel smoke were recruited sequentially. Patients were never smokers, stable and ambulatory on inclusion and excluded if they had complications or significant comorbidities.

Study design

This was an institute based prospective observational study. All patients responded to a questionnaire seeking information about cardinal respiratory symptoms and was filled in by the same investigator. Detailed history of biomass fuel smoke exposure in terms of exposure index (average number of hours of exposure per day multiplied by the number of years of cooking) [8] and ventilation were also recorded. All patients underwent spirometry with reversibility testing, chest radiograph and high resolution computed tomography (HRCT) of the thorax. Spirometric findings were classified as normal and abnormal. The abnormal pattern was further divided into obstructive and non-obstructive defect. Obstructive ventilatory impairment was defined as post-bronchodilator $FEV_1/FVC <$ lower limit of normal (LLN) while the non-obstructive ventilatory impairment comprised patterns suggestive of restriction or mixed ventilatory defect [9]. All HRCT images were analysed independently by a pulmonologist and a radiologist, both with more than 30 years of experience. The diagnostic criteria adopted for BAF [4, 10] were: (1) long-standing history of biomass fuel smoke exposure, (2) on HRCT, the occurrence of multifocal narrowing of involved bronchus when present and (3) visual confirmation on fibreoptic bronchoscopy (FOB) of (a) bluish-black mucosal pigmentation, along with (b) narrowed/distorted bronchus. FOB was done only in those who gave a written informed consent again prior to the procedure.

Grouping of study subjects

Based on the FOB findings, the study population was divided into three groups: Group 1: patients with anthracotic pigmentation and narrowed/distorted bronchi (BAF), (Fig. 1A) Group 2: patients with only anthracotic pigmentation without narrowing/distortion (Fig. 1B) and Group 3: patients with a normal tracheobronchial tree.

Ethics

Patients were recruited if they gave a voluntary, informed and written consent. Subsequently, written consent for FOB was also taken prior to conducting the procedure. The study was approved by the institutional Human Ethics Committee.

Statistical analysis

Data are reported as mean ± SD or number (%). Analysis was performed using Statistical Package for the Social Sciences Version 21.0 (IBM Corporation, Armonk, NY, USA). The normalcy of distribution was assessed using the Shapiro-Wilk test while Levene test was used to determine homogeneity of variance. The data was normally distributed in all the three groups and thus the groups were compared using ANOVA test for continuous variables and the chi-square test for categorical variables. Post-hoc analysis was performed using the Tukey's post hoc test. In addition, Pearson's correlation coefficient was to determine correlation between variables. P-value of < 0.05 was considered statistically significant.

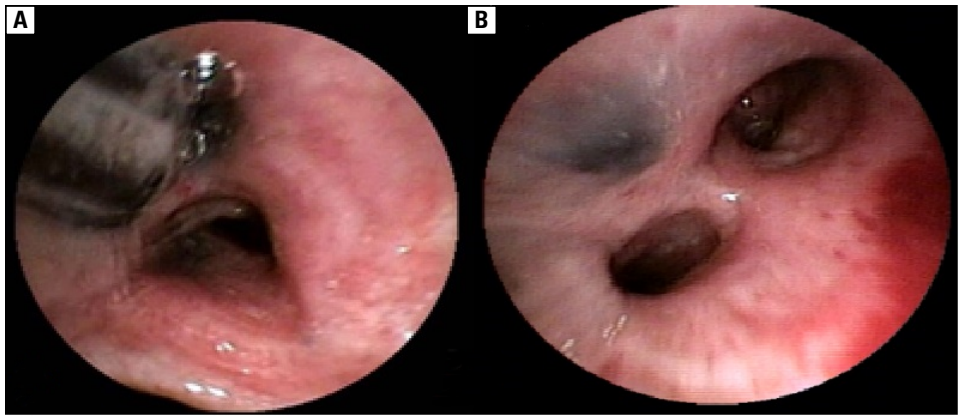

Figure 1. A — fiberoptic bronchoscopy image showing anthracotic pigmentation along with narrowing/distortion of the right middle lobe bronchus confirmatory of bronchial anthracofibrosis; **B** — fiberoptic bronchoscopy image showing anthracotic patch in the wall of right upper lobe bronchus

Table 1. Age and biomass fuel smoke exposure among the three groups

	BAF (n = 24) Group 1	Anthracosis (n = 17) Group 2	Normal bronchoscopy (n = 19) Group 3	p-value (ANOVA)	Post-hoc analysis between the groups (Tukey's post hoc test)
Mean age in years	61.5 ± 11.5	57.6 ± 8.1	54.9 ± 8.4	0.049*	Group 1 vs Group 2 : 0.42 Group 1 vs Group 3 : 0.04* Group 2 vs Group 3 : 0.69
Mean hours of exposure/day	5.75 ± 0.85	4.53 ± 0.51	4.89 ± 0.87	< 0 .001*	Group 1 vs Group 2 : 0.0001* Group 1 vs Group 3 : 0.0001* Group 2 vs Group 3 : 0.004*
Mean years of exposure	32.3 ± 9.9	27.94 ± 9.7	21.3 ± 4.9	< 0.001*	Group 1 vs Group 2 : 0.0001* Group 1 vs Group 3 : 0.0001* Group 2 vs Group 3 : 0.984
Mean exposure index	181.5 ± 50.6	127.9 ± 44.2	106.3 ± 24.6	< 0.0001*	Group 1 vs Group 2 : 0.0001* Group 1 vs Group 3 : 0.0001* Group 2 vs Group 3 : 0.275

*statistically significant

Table 2. Clinical symptomatology in the three groups

	BAF (n = 24) Group 1	Anthracosis (n = 17) Group 2	Normal bronchoscopy (n = 19) Group 3	p-value
Cough	23 (95.83%)	16 (94.12%)	19 (100%)	0.59
Dyspnoea	19 (79.17%)	15 (88.24%)	19 (100%)	0.10
Sputum	11 (45.83%)	4 (23.53%)	6 (31.58%)	0.31
Chest pain	4 (16.67%)	4 (23.53%)	2 (10.53%)	0.57
Haemoptysis	7 (29.17%)	1 (5.88%)	3 (15.79%)	0.15
Wheeze	7 (29.17%)	5 (29.41%)	5 (26.32%)	0.97

Results

Eighty consecutive respiratory symptomatics, all females, never smokers with biomass fuel smoke exposure were enrolled but 20 were excluded as they refused FOB. The remaining 60 patients (mean age of 58.3 ± 9.96 years) were categorised after FOB as Group 1: BAF 24/60 (40%), Group 2: bronchial anthracosis 17/60 (28.3%) patients and Group 3: normal appearance: 19/60 (31.7%). Though Group 1 patients had significantly higher mean age (Table 1), there was no significant differences in presentation of three groups (Table 2). There was a signi-

ficant difference in the mean exposure index between the three groups (p = 0.0001). Patients in Group 1 had significantly higher exposure index (Fig. 2) as compared to the other two groups (Group 1 vs Group 2: p = 0.0001; Group 1 vs Group 3: p = 0.0001; Group 2 vs Group 3: p = 0.27) (Table 1).

Pulmonary function testing (PFT)

Spirometry was performed in 52/60 patients. In 7/24 Group 1 patients, the procedure was not performed as four had recent haemoptysis while another three could not perform the manoeuvre as also one patient from Group 2.

An analysis of the spirometric findings in our study revealed that a majority of patients in all the three groups had an abnormal spirometry (Group 1: 11/17 [64.7%], Group 2: 9/16 [56.3%] and Group 3: 16/19 [84.2%]; p = 0.18). On spirometry, the most common ventilatory defect was a non-obstructive pattern (Group 1: 8/17 [47.1%] vs Group 2: 9/16 [56.3%] vs Group3: 12/19 [63.2%]; p = 0.62). An obstructive pattern was seen in (Group 1: 3/17 [17.6%] vs Group 2: 0/16 (0%) vs Group 3: 4/19 [21.1%]; p = 0.15). A normal spirometry was documented in (Group 1: 6/17 [35.5%] vs Group 2: 7/16 [43.7%] vs Group 3:3/19 [15.8%]; p = 0.18) patients. There was no significant difference in the spirometric parameters between the three groups (Table 3).

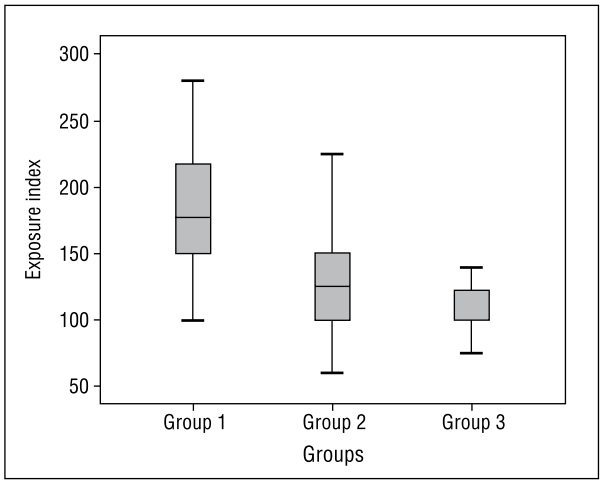

Figure 2. Box and whisker plot showing the biomass fuel smoke exposure index in all three groups

Six minute walk test (6MWT)

In Group 1, the mean 6MWT distance was 235.4 ± 69.97 metres, in Group 2 331.8 ± 105.97 metres and in Group 3 270 ± 91.7 metres. Patients in Group 1 walked significantly lesser distance as compared to Group 2 (p = 0.003) but there was no significant difference between Groups 1 and 3 (p = 0.41) and Groups 2 and 3 (p = 0.09). In Group 1, significant desaturation (a fall in $SpO_2 \geq 4\%$ from the baseline) [11] was seen in 14/24 (58%) patients, in Group 2 6/17 (35.3%) and in Group 3 6/19 (31.6%).

Chest radiograph

All 24 Group 1 patients had an abnormal chest X-ray with consolidation in 8/24 (33.3%) patients and reticulonodular pattern in 7/24 (29.2%). Ill-defined opacities abutting right cardiac border suggestive of middle lobe sydrome (Fig. 3A, B) and linear shadows were observed 6/24 (25%) patients each, atelectasis in 2/24 (8.3%) and hilar lymphadenopathy in 1/24 (4.1%) subjects.

In Group 2, reticulonodular pattern was seen in 5/17 (29.4%) patients, linear shadows in 4/17 (23.4%), consolidation, hilar lymphadenopathy and a normal study in 3/17 (17.6%) patients each. In Group 3, the chest radiograph was normal in 8/19 (42.1%) patients, reticulonodular pattern in

Table 3. Spirometry findings in the three groups

Parameters	BAF (n = 17) Group 1	Anthracosis (n = 16) Group 2	Normal bronchoscopy (n = 19) Group 3	p-value (ANOVA)	Post-hoc analysis between the groups (Tukey's post hoc test)
	Mean ± SD	Mean ± SD	Mean ± SD		
FEV1	67.1 ± 18.3%	63.4 ± 20.4%	53.8 ± 20.3%	0.12	Group 1 vs Group 2: 0.86 Group 1 vs Group 3: 0.12 Group 2 vs Group 3 : 0.32
FVC	79.4 ± 13.3%	68.8 ± 16.3%	69.7 ± 15.5%	0.08	Group 1 vs Group 2: 0.12 Group 1 vs Group 3: 0.14 Group 2 vs Group 3: 0.98
FEV_1/FVC	69.8 ± 10.4%	75 ± 12.9%	64.2 ± 14.9%	0.06	Group 1 vs Group 2: 0.48 Group 1 vs Group 3: 0.41 Group 2 vs Group 3: 0.05

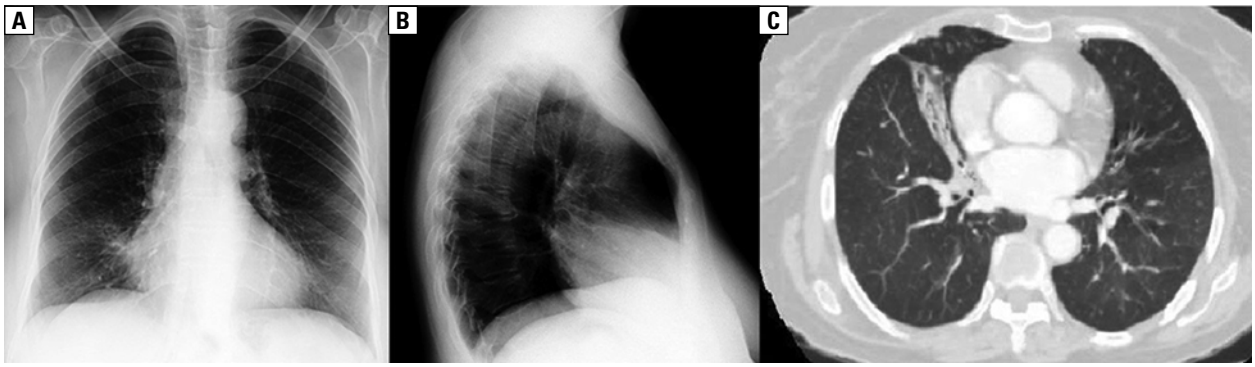

Figure 3. A — chest X-ray postero-anterior view showing ill-defined opacity in the right mid and lower zones abutting the right cardiac border with loss of cardiac silhouette suggestive of right middle lobe syndrome; **B** — chest X-ray right lateral view showing a wedge-shaped density extending from the hilum anteriorly and inferiorly towards the chest wall, confirming the presence of middle lobe syndrome; **C** — high-resolution CT of the thorax (lung window) showing a trapezoidal opacity with its base towards the hilum and contiguous with the right cardiac border confirming middle lobe syndrome

4/19 (21.1%), linear shadows and consolidation in 3/19 (15.8%) subjects each.

HRCT thorax

In Group 1, segmental collapse and consolidation were seen in 13/24 (54.2%) patients each, fibrotic lesions in 11/24 (45.8%), bronchial narrowing in 7/24 (29.3 %), middle lobe syndrome (Fig. 3C) in 6/24 patients (25%), multifocal bronchial stenosis and peribronchial cuffing in 5/24 (20.8%) patients each. Mediastinal lymphadenopathy was reported in 5/24 (20.8%) patients, emphysema in 4/24 (16.7%), traction bronchiectasis in 3/24 (12.5%) and interstitial pattern in one. In Group 2, parenchymal bands was documented in 14/17 (82.4%) patients, traction bronchiectasis in 6/17 (35.3%), ground glass opacity and mediastinal lymphadenopathy in 4/17 (23.5%) subjects each. In Group 3 patients, parenchymal bands was seen in 11/19 (57.9%) patients, traction bronchiectasis and emphysema in 5/19 (26.3%) subjects each.

Multifocal bronchial stenosis (Fig. 4) and peribronchial cuffing was seen in 5 patients each while tree in bud appearance and usual interstitial pneumonia in one patient each. All these findings were documented exclusively in patients with BAF (Table 4).

Bronchoscopy findings

In both groups, the middle lobe bronchus was most commonly affected in 23/41 subjects (Group 1: 15/24 [62.5%] vs Group 2: 8/17 [47.1%]; [p = 0.32]). This was followed by the right upper lobe bronchus in 17/41 patients of both groups (Group 1:10/24 [41.7%] vs Group 2: 7/17 [41.2%]; [p = 0.97]). The left upper lobe bronchus was involved in 15/41 patients (Group 1: 7/24 [29.2%] versus Group 2: 8/17 [47.1%]; [p = 0.24]) while the left lower lobe bronchus was affected exclusively in 4 patients with anthracosis (Group 2) (Group 1: 0/24 vs Group 2 4/17 [23.5%]; [p = 0.01]).

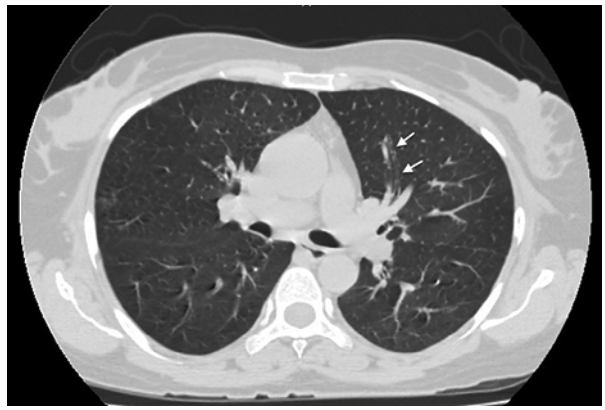

Figure 4. High resolution computed tomography of the thorax (lung window) showing multifocal narrowing of the left upper lobe bronchus (white arrows)

Other associated pulmonary diseases

Tuberculosis was reported in 4/60 (6.6%) patients. In Group 1, a positive microbiological and histopathological evidence for *Mycobacterium tuberculosis* was observed in 3/24 (12.5%) patients while one patient in Group 3 had associated tuberculosis. Adenocarcinoma and pneumonia were associated findings in 2/24 (8.3%) patients while one patient had interstitial lung disease (usual interstitial pneumonia pattern [UIP]) associated with BAF. Adenocarcinoma was associated in one Group 2 patient. Associated COPD was seen in 8/24 (33.33%) patients in Group 1, 5/17 (29.41%) patients in Group 2 and 14/19 (73.68%) in Group 3.

Table 4. Comparison of HRCT chest findings between patients with BAF, anthracosis and normal bronchoscopy

HRCT findings	BAF (n = 24)		Anthracosis (n = 17)		Normal bronchoscopy (n = 19)		p-value
	Freq.	%	Freq.	%	Freq.	%	
Parenchymal bands	11	45.8	14	82.4	11	57.9	0.06
Segmental collapse	13	54.2	3	17.6	1	5.3	**0.001***
Consolidation	13	54.2	3	17.6	1	5.3	**0.001***
Bronchial narrowing	7	29.2	0	0.0	3	15.8	**0.04***
Middle lobe syndrome	6	25	0	0	0	0	**0.006***
Multifocal bronchial stenosis	5	20.8	0	0.0	0	0.0	**0.01***
Peribronchial cuffing	5	20.8	0	0.0	0	0.0	**0.01***
Emphysema	4	16.7	1	5.9	5	26.3	0.25
Mediastinal lymph nodes	5	20.8	4	23.5	2	10.5	0.55
Traction bronchiectasis	3	12.5	6	35.3	5	26.3	0.21
Mosaic pattern	5	20.8	3	17.6	2	10.5	0.82
Ground glass opacification	3	12.5	4	23.5	4	21.1	0.62
Tree in Bud	1	4.2	0	0.0	0	0.0	0.46
Cavitary lesion	3	12.5	0	0.0	2	10.5	0.33
Interstitial pattern	1	4.2	0	0.0	0	0.0	0.46
No abnormal finding	0	0.0	0	0.0	0	0.0	

*Statistically significant

Correlation

In Group 1 patients, the exposure index had significantly inverse correlation with six minute walk distance ($r = –0.53$; $p = 0.008$). In addition, exposure index also had a significant inverse correlation with spirometric parameters (FVC: $r = –0.50$, $p = 0.04$; FEV_1: $r = –0.51$, $p = 0.03$; FEV_1/FVC: $r = –0.48$, $p = 0.04$) signifying worse lung functions with greater degree of exposure. In Groups 2 and 3, among the various parameters, only age had a significant positive correlation with exposure index (Group 2: $r = 0.55$, $p = 0.02$; Group 3: $r = 0.52$, $p = 0.02$). In Group 1 patients, age had a positive correlation however this was not significant. This has been depicted in Table 5.

Discussion

Our study has shown that BAF can occur in 40% of respiratory symptomatics elderly females with biomass fuel smoke exposure. In addition, another 28.3% of the subjects had anthracosis. All our patients were females from rural background with long standing exposure to biomass fuel smoke while cooking in poorly ventilated areas. Since only never smokers were enrolled, male subjects with biomass fuel smoke exposure were smokers and had to be excluded. Gupta and Shah [10] in their review on BAF observed that 632/792 (79.8%) patients with BAF were females. The mean exposure index in 42 non-smoking females with COPD from Brazil [12] was 209.1 ± 98.4 hour-years. A multivariate analysis from India [13] calculated that minimum threshold of exposure index of 60 hour-years was a significant risk factor for occurrence of chronic bronchitis in women. Our study too highlighted this aspect as mean years of exposure as well as mean exposure index was significantly higher in patients with BAF (BAF-181.5 ± 50.6 hour-years vs anthracosis- 127.9 ± 44.2 hour-years).

All patients with BAF had an abnormal radiological study with consolidation and middle lobe collapse being the prominent finding on chest radiograph. On HRCT thorax, segmental collapse and consolidation were commonest observations along with parenchymal bands. Bronchial abnormalities in form of narrowing, multifocal bronchial stenosis, a feature indicative of BAF and peribronchial cuffing were observed. An unusual association of BAF with UIP was observed which was documented in detail [14]. In two studies from Korea

Table 5. Correlation between variables in Groups 1, 2 and 3

		Age	Exposure index	6MWD	FVC	FEV_1	FEV_1/FVC
GROUP 1							
Age	Pearson correlation	1	0.332	–0.135	0.232	0.307	0.077
	Significance		0.113	0.528	0.37	0.23	0.76
Exposure index	Pearson correlation	0.332	1	–0.528*	–0.501*	–0.514*	-0.485*
	Significance	0.113		0.008	0.040	0.035	0.048
6MWD	Pearson correlation	–0.135	–0.528**	1	0.749**	0.877*	0.789**
	Significance	0.528	0.008		0.001	0.0001	0.0001
GROUP 2							
Age	Pearson correlation	1	0.559*	–0.206	–0.074	0.120	0.206
	Significance		0.02	0.427	0.786	0.659	0.443
Exposure index	Pearson correlation	0.559*	1	–0.110	–0.204	–0.113	0.03
	Significance	0.02		0.673	0.448	0.678	0.909
6MWD	Pearson correlation	–0.206	–0.110	1	–0.057	–0.154	–0.106
	Significance	0.427	0.673		0.833	0.570	0.695
GROUP 3							
Age	Pearson correlation	1	0.529*	–0.112	0.263	0.068	-0.086
	Significance		0.02	0.647	0.277	0.781	0.726
Exposure index	Pearson correlation	0.529*	1	–0.177	–0.160	–0.372	–0.387
	Significance	0.02		0.469	0.512	0.117	0.101
6MWD	Pearson correlation	–0.112	–0.177	1	0.430	0.279	0.100
	Significance	0.647	0.469		0.066	0.247	0.683

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

[15, 16] assessing CT features, bronchial narrowing/ /atelectasis was the most common finding. Of the 58 patients with isolated BAF from Iran [17], peribronchial soft tissue thickening, bronchial narrowing or obstruction, segmental atelectasis, and lobar or multilobar collapse were the major findings. The CT findings in the two patients reported from India [7, 14] included a MLS with air bronchogram and multifocal stenosis of RML bronchus in one [7], while the other had a UIP pattern with multifocal narrowing of left upper lobe bronchus [14]. In our study, multifocal bronchial stenosis and peribronchial cuffing were exclusively observed in patients with BAF. Multifocal bronchial stenosis, when present, can be considered as a feature characteristic of BAF [4, 10].

Functional status assessment revealed that walk distance in patients with BAF was significantly lower as compared to those with anthracosis only. In addition, on 6MWT more than half the BAF patients (58.3%) desaturated with a fall in $SpO_2 \geq 4\%$ from the baseline which was considered significant [11]. On functional assessment, patients with BAF fared poorer than those with anthracosis, a finding which is yet to be documented in the literature. Although, obstruction is most commonly observed on PFT in patients with BAF [16, 18] a non-obstructive (suggestive of restriction/mixed defect) or even a normal pattern can be encountered. In our study too, obstructive, non-obstructive and normal patterns were observed with normal spirometry being the most frequent finding followed by non-obstructive and obstructive defects. In all three groups, most of the patients had an abnormal spirometric finding (obstructive or non-obstructive defect). This could be explained from the fact that all the three groups had long standing exposure to biomass fuel smoke.

Biomass fuel smoke exposure can lead to both an obstructive as well as a restrictive ventilatory defect. This was reflected in the spirometric findings in our patients where the most common ventilatory defect was a non-obstructive pattern (suggestive of restriction/mixed defect). Biomass fuel smoke exposure probably leads to activation

of pulmonary fibroblasts and an increased production of fibronectin [19]. This could possibly explain the non-obstructive pattern (suggestive of restriction/mixed defect) on spirometry as a result of increased fibrosis. In addition, a normal spirometric finding can be seen in patients with biomass fuel smoke exposure. In a study from Korea in patients with BAF, half of them had a normal spirometric finding [20]. Similarly, a normal spirometry was the most common finding in our patients with BAF as well as anthracosis. Furthermore, in Group 1, it was observed that there was a significant inverse correlation between exposure index, 6MWD and spirometric parameters. Patients with BAF had a greater degree of biomass fuel smoke exposure, covered lesser distance on six-minute walk test.

BAF, as visualised on FOB, affects the mucosa around branching points of the bronchus [16] and commonly involves RML as also both upper lobes. In 54 patients from Korea [15], RML was affected in 34 (63%) subjects. Subsequently, another large Korean study [16] confirmed that RML was most frequently damaged (229/333 [68.8%]). We too noted that RML bronchus was mostly affected followed by both upper lobe bronchi. In a report of 30 patients with anthracosis alone, pigmentation was frequently observed in both upper lobes and RML bronchi [21]. In our patients with anthracosis alone, pigmentation was largely seen in the RML and the LUL bronchi followed by RUL and LLL lobe bronchi.

Tuberculosis was most commonly associated disease in our entire study population documented in 4/60 patients (6.6%) followed by malignancy (5%). In patients with BAF, active tuberculosis was associated in 3/24 (12.5%) patients while a history of antituberculous therapy in the past was reported in 6/24 (25%) patients. Malignancy and pneumonia were associated in 2/24 (8.3%) patients each. Gupta and Shah [10] in their review of 907 patients with BAF observed that incidence of tuberculosis, pneumonia and malignancy were 31.4%, 30% and 4.8% respectively.

The small sample size was the major limitation in our study as many patients refused to undergo an invasive procedure like FOB. Furthermore, all our patients were females as males who had exposure to biomass fuel smoke were also smokers and had to be excluded.

Conclusion

Not surprisingly, all our patients were females with significant biomass fuel smoke exposure. In comparison to those with anthracosis, patients with BAF had poor functional status. Multifocal bronchial stenosis and peribronchial soft tissue cuffing were specific imaging signs for BAF. Since exposure to biomass fuel smoke is a risk factor inherent to COPD and BAF, most patients are often labelled as COPD without undergoing further workup to exclude BAF [4, 10]. Nearly two decades have passed since this clinical entity was highlighted but it is yet to be ascertained as to why some subjects exposed to biomass fuel smoke develop BAF while others develop anthracosis or even remain unaffected by both these entities. Though our patients with BAF had a significantly greater degree of biomass fuel smoke exposure and significantly poorer functional status than those with anthracosis, it would be intriguing to speculate whether BAF or anthracosis are two different stages of the same disease process or two separate clinical phenomenon. The pathophysiology and clinical implications of this disease process still needs to be elucidated. Since FOB continues to remain the only diagnostic modality confirmatory of BAF/anthracosis, it is imperative not only to develop non-invasive modalities for an early diagnosis but also to formulate preventive and management strategies for this clinical entity.

Conflict of interest

The authors declare no conflict of interest.

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