ECRONICON OPEN ACCESS

EC CLINICAL AND MEDICAL CASE REPORTS
Case Report

Diagnostic Assessment Score of Pulmonary Anthracosis: Review

Cuneyt Tetikkurt*, Nejdiye Güngördü, Mert Savcı and Enes Furkan

Professor, Department of Pulmonary Medicine, Cerrahpasa Medical Faculty, Istanbul University Cerrahpasa, Istanbul, Turkey

***Corresponding Author:** Cuneyt Tetikkurt, Professor, Department of Pulmonary Medicine, Cerrahpasa Medical Faculty, Istanbul University Cerrahpasa, Istanbul, Turkey.

Received: June 14, 2023; **Published:** June 30, 2023

Abstract

Anthracosis is superficial black discoloration of bronchial mucosa resulting from repeated exposure to air pollution, inhalation of smoke, or coal dust that is caused by the accumulation of carbon in the lungs. Biomass incurrence or vulnerability emerges as the most common etiologic factor. Diagnosis is usually reached by bronchoscopic examination in patients with compatible findings while identification of anthracosis may lead to a challenge in regard to differential diagnosis from malignancy, chronic obstructive lung disease, tuberculosis, or fungal infection.

We present three cases of pulmonary anthracosis to discuss the clinical, radiologic, and bronchoscopic findings that may usually lead to a diagnostic challenge for clinicians. We set forth an assessment score analysis to reach a final accurate clinical diagnosis. The primary aim is to put forward a diagnostic algorithm analysis based on clinical, bronchoscopic, radiologic, and nuclear imaging manifestations for anthracosis identification based on our three cases along with the current literature data. This score analysis does not only provide a definitive diagnosis, but also ensures the most appropriate diagnostic pathway for clinicians in suspected cases.

Keywords: *Pulmonary Anthracosis; CT; Bronchoscopy; Pathology*

Introduction

Anthracosis occurs due to the accumulation of carbon, silica, and quartz particles and crystals in macrophages, mucosa, and submucosa of the lungs[1]. Occupational or indoor exposures to these particles predispose to pulmonary anthracosis. Dark and black discoloration of superficial mucosal lesions are visible in the normal or pathologic bronchial background and the bronchi may become highly fragile [2-4]. Prevalence of anthracosis is roughly between 3.4% and 21%, based on data available among patients who had undergone bronchoscopy for other causes of pulmonary diseases [5,6]. Dust particle exposure leading to anthracosis such as coal, tile, mica, silica, aluminum, and silicon, or biomass smoke that may may arise from many different sources has been proposed to be associated with the etiology of anthracosis. Quartz and iron deposits appear to be the most frequent etiological plaques found in the bronchial lumen of anthracosis patients [7,8].

In the current paper, we present the clinical, laboratory, and imaging results of three patients with pulmonary anthracosis. Our aim is to present a diagnostic score assessment based on the clinical data of the three cases along with the literature data. With the aforementioned

pulmonary anthracosis assessment analysis, we conclude that a definitive and an accurate clinical diagnosis could be reached in these patients even without any requirement for histopathological verification.

Case Report

Patient 1

A 90 year-old male was admitted for dyspnea and mild expectoration of six months. He was a non-smoker and did not have a personal or family history of a significant disease. The patient reported 30 years of biomass exposure. Physical examination revealed prolonged expiration and fine rales in the lung bases. Serum biochemistry was normal except for a leucocyte count of 11.200 cells/μL, an ESR of 22 mm/h, a D-dimer of 0.92 mg/L, and a CRP of 25 mg/L. ECG revealed sinus rhytm of 90/min with a normal cardiac axis. Chest x-ray and thorax CT showed a 20 mm nodule over the right hilum. Pulmonary function tests displayed moderate obstruction. PET/CT revealed a 21X20 mm nodule in the hilar region with a 12.41 SUVmax (Figure 1), a 6 mm nodule adjacent to horizontal fissure with a slightly increased SUVmax of 3.21, and a few nodules accompanied by increased FDG uptake (SUVmax: 6.89) were observed in the apical and posterobasal segments of the left lower lobe. Bronchoscopy revealed bilateral disseminated black discoloration of the mucosa. Mucosal inflammatory changes, erythema, thickened mucosal corrugations, prominence of segmental carinae, and mild narrowing of segmental bronchi were detected in bronchoscopy. Bronchial lavage smear and cultures were negative for bacteria, fungus, or mycobacteria. Histopathology of the biopsy specimens revealed granulomatous inflammation, reactive hyperplasia, and macrophage clusters with CD^{68} positivity.

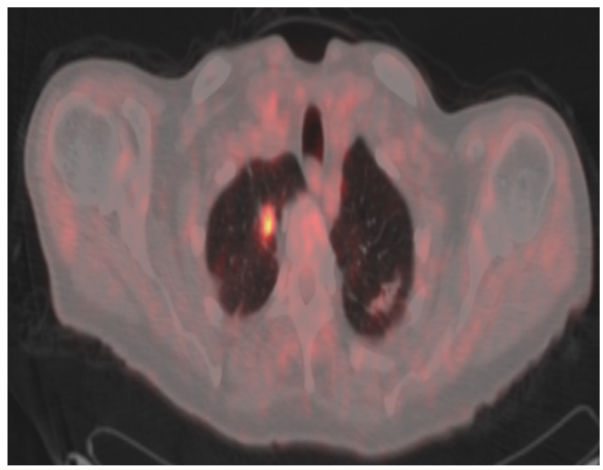

Figure 1: *PET/CT revealing a 21x20 mm soft tissue lesion with a 12.41 SUVmax at the right upper lobe apical segment.*

Patient 2

A 79 year-old female presented with a dry cough. She had biomass fuel smoke exposure for about 20 years. Her personal history included diabetes and hypertension while family history did not elicit any disease of concern. Physical examination revealed ronchi and coarse rales in both lower lung zones. CBC showed a leucocytosis of 10.900 cells/μL. Serum biochemistry was normal except for a mild CRP elevation of 32 mg/L. ECG showed sinus rhythm of 86/min with a normal cardiac axis. Chest x-ray and thorax CT revealed infiltrations, homogenous consolidation, atelectasis in the right upper lobe (Figure 2) and, a 12 mm nodule obliterating the right upper lobe orifice.

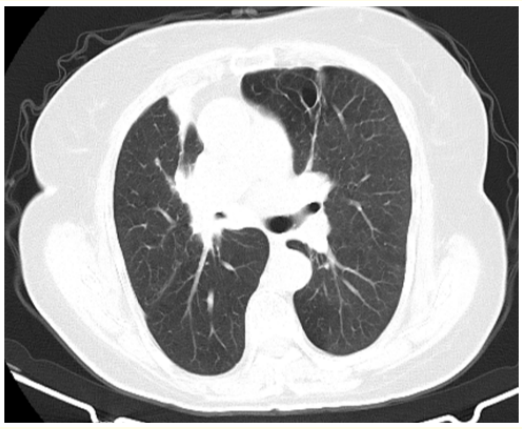

Figure 2: *Thorax CT showing atelectasis and homogenous infiltration at the right upper lobe anterior segment.*

Pulmonary function tests displayed a mild obstructive pattern. PET/CT showed moderate tracer uptake in these regions compatible with granulomatous inflammation. Bronchoscopy revealed multiple focal protruded black discoloration of the mucosa, mild or moderate obliteration of the segmental bronchi, increased vascularity, thickening of mucosal corrugations, and segmental carinae. The right upper lobe orifice was significantly narrowed and revealed compatible changes with malignancy. Bronchial lavage smear and cultures were negative for bacteria, fungus, or mycobacteria. Pathologic examination of bronchial biopsy showed CD^{68} positive macrophages in clusters, granuloma-like macrophage aggregates, and multinucleated giant cells.

Patient 3

A 66 year-old female was admitted for dyspnea, cough, and mild sputum production. The patient was a smoker of 20 p-years. She had indoor biomass smoke exposure for 15 years and had COPD for ten years. Her father had died of lung cancer, mother had hypertension and diabetes. Physical examination revealed fine rales in both lower lung zones. CBC showed a leucocytosis of 11.000 cells/μL. Serum biochemistry was normal other than a mildly elevated CRP of 16 mg/L and an LDH of 265 U/L. ECG showed sinus rhythm of 82/min with a normal cardiac axis. Chest x-ray revealed decreased lung attenuation. Pulmonary function tests displayed a moderate obstructive obstructive lung disease. Thorax CT showed a 15 - 16 mm soft tissue opacity around the right upper lobe bronchus causing mild obliteration. PET/CT revealed a 16 mm nodule with a 10.8 SUVmax at the RUL apical segment. Bronchoscopy displayed mucoid secretions, focal black mucosal discoloration, thickening of mucosal folds, and obliteration of the right upper lobe bronchus compatible with malignancy. Bronchial lavage smear and cultures were negative for bacteria, fungus, or mycobacteria. Histopathologic examination of the bronchial biopsy specimens revealed granulomatous inflammation, anthracotic macrophage aggregates with CD^{68} positivity, and multinucleated giant cells.

Discussion

Anthracosis is black pigment discoloration of bronchial mucosa that develops due to the uptake of carbon-like particles in the cytoplasm of macrophages in the bronchial wall that may extend to the respiratory bronchioles [9]. It may distort and narrows the bronchial lumen with extensive deposition of carbon in the main bronchial walls leading to severe submucosal edema, bronchial stenosis, and protruded mucosal folds. In severe cases, anthracosis may distort, narrow the bronchial lumen, and induce lung collapse [9-11]. Biomass or

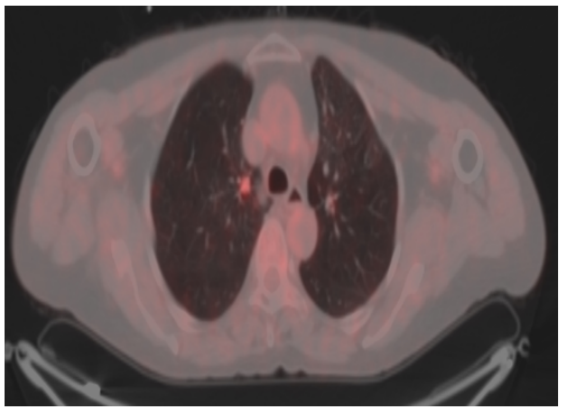

Figure 3: *PET/CT revealing a 16 mm nodule with a 10.8 SUVmax at the right upper lobe apical segment.*

occupational exposure is the most common risk factor for anthracosis. Data from large series of patients who underwent bronchoscopy for other other etiologies have shown that the frequency of simple anthracosis is approximately 3.4 - 21% which is not an uncommon occurrence [12,13]. As anthracosis resembles many other lung diseases, final diagnosis may emerge as a diagnostic dilemma for clinicians. An agreed consensus does not exist for an accurate final diagnosis. The coexistence of other lung disorders such as COPD, lung cancer, or granulomatous diseases may lead to a deadlock. Consequently, these patients should be evaluated and followed up for various pulmonary diseases including malignancy, chronic obstructive lung or granulomatous diseases, pneumonia, tuberculosis, and fungal infection. Although bronchoscopy is the gold standart for diagnosis, presence or absence of findings compatible with anthracosis may rule out the existence of other coexisting diseases such as chronic obstructive lung diseases, malignancy, granulomatous disorders, or pulmonary infection.

Patient history is the most important step for initial diagnosis, especially in revealing the presence of biomass or occupational exposure. Symptoms such as cough or dyspnea may come out in many other lung diseases. As for the laboratory findings, mild ESR or CRP elevation, and the presence of an obstructive pattern are not useful since these may ocur as the consequence of various other respiratory disorders. Chest X-ray is reported to be normal in only 7% of subjects revealing non-homogeneous pulmonary infiltrations, fibrotic lesions, subsegmental atelectasis, or mass lesions [14]. Although a normal radiological appearance is rare in these patients, the contribution of imaging to diagnosis remains extremely limited because findings of anthracosis are equivocal and non-specific. CT may reveal more significant manifestations of anthracosis such as mediastinal or hilar lymphadenopathy in 94% while lymph node calcification is observed in 57% of these patients. Bronchial narrowing with or without atelectasis develops in 94% and involvement might be unilateral or bilateral. The right middle lobe, followed by upper lobes were reported as the most common sites of involvement [8,9,15]. CT was unremarkable in 17% of simple anthracosis and in 6% of the anthracofibrosis cases while pleural disease was observed in approximately 25% of the patients with anthracofibrosis [6,14]. MRI demonstrated a low sensitivity to differentiate bronchial anthracofibrosis from lung cancer [16]. FDG-PET/CT may reveal mild to moderate tracer uptake in anthracosis leading to equivocal findings for differentiating granulomatous inflammation, infection, or malignancy [17,18]. Consequently, almost all imaging modalities in anthracosis display equivocal or indistinct findings. Diagnostic assessment score analysis was put forward in the light of literature data and the findings of our cases described above. Point scoring of the relevant patient manifestations or laboratory features was calculated considering the incidence and the specificity of the factor reported in the literature for anthracosis.

Bronchoscopy is the hallmark for anthracosis diagnosis revealing distinctive characteristics. The foremost attribute is the focal protruded black discoloration of the mucosa with or without bronchial narrowing [6,8,9]. Thickening of mucosal folds, segmental or subsegmental carinae, and obliteration of bronchi is common. Bronchial swelling due to submucosal edema or inflammation, increased vascularity, and erythema emerge as other associated findings. These changes may occur as local or diffuse lesions, either unilaterally or bilaterally. Tracheal involvement is quite rare [19]. Histopathology is the final diagnostic step although equivocal findings may be observed in a significant number of patients. Anthracosis primarily involves the bronchioles. Carbon-like particles may exist in the macrophage cytoplasm of the bronchial wall and in the mediastinal lymph nodes [20,21]. Anthracotic macrophages in clusters or singly is common and storiform spindle cell arrangement or granuloma-like aggregates of macrophages may be observed. Submucosal fibrosis may occur in the bronchial wall with an intact epithelial lining [22,23]. Cytology may show anthracotic macrophages single or dispersed in variously sized aggregates, multinucleated giant cells without necrosis or atypical cells [5]. CD^{68} positivity may emerge revealing macrophages containing pigment [24]. Zai and Lui revealed that anthracosis may coexist with interstitial lung diseases that may emerge as a notable finding for differential diagnosis in anthracosis patients [25]. Pleural anthracosis may lead to alterations in the pleural lymphatic structures or function. These pathological changes in the pleural lymphatics may cause decreased lymphatic drainage and thereby interfere with nodal skip metastasis [26]. The aforementioned negative role in N_2 skip metastasis may cause a dilemma in patients with malignancy.

All of our patients exhibited significant and characteristic mutual features. The common symptom denominator was cough and dyspnea. While clubbing was not observed, it played a significant role in the differential diagnosis of many lung disorders, especially the interstitial lung diseases. Serum biochemistry was normal except for mild leucocyte, CRP, and ERS elevations revealing subtle inflammation. Chest x-ray and CT revealed hyperlucency, infiltrations, fibrotic lesions, mass-like lesions, and nodules. PFT showed obstructive pulmonary dysfunction in all patients. PET/CT displayed mild or moderate ^{18}FDG uptake revealing granulomatous inflammation or infection while in some lesions SUVmax value was compatible with malignancy. Bronchoscopy was the gold standard for diagnosis by detecting focal mucosal black areas and inflammatory changes consistent with anthracosis. Final definite diagnosis was reached by histopathological examination of the bronchoscopic mucosal biopsies that revealed distinctive and authentic features of anthracosis.

The following conclusions were reached in regard to the clinical profile of our patients and anthracosis data in literature. Demonstration of biomass exposure in patient history was the most crucial initial diagnostic step for diagnosis. In contrast, symptoms and physical examination findings lacked suggestive or substantive benefit for anthracosis. Complete blood count, serum biochemistry and pulmonary function tests did not provide a conclusive support. Although imaging modalities can ensure a significant contibution to diagnosis, they may lead to very ambiguous results in some cases and reveal equivocal findings for the differential diagnosis of malignancy, infection, or granulomatous inflammation. Presence of black anthracotic pigment areas in the bronchial mucosa render bronchoscopy the hallmark of anthracois diagnosis. Although pathological examination can indicate anthracosis, absence of decisive findings in biopsy may lead to decreased diagnostic yield. In conclusion, anthracosis diagnosis requires the assessment of all patient manifestations from a single perspective window implying that a diagnostic assessment score analysis is undispensable.

Considering the aforementioned points, we set forth a diagnostic assessment score for an accurate clinical diagnosis of anthracosis. This appraisal innovation analysis was evocated in regard to the prevalence of the clinical, radiological, bronchoscopic, and pathological manifestations reported in the current the literature. The main target was to reach a definitive diagnosis, especially in patients with equivocal manifestations for anthracosis, or at least to promote an explicit clinical support thereby to leading the clinician in the factual or the definite diagnostic pathway. Patients were classified into four categories with respect to the clinical profile consisting of history, symptoms, laboratory, radiologic, and pathologic manifestations as inconsistent, low, intermediate, and definitive. The clinical manifestations of anthracosis are revealed in Table 1 and the diagnostic probability of anthracosis is shown in Table 2. The minimum diagnostic score 25 among our patients while the other two had 27 and 28 points, respectively. Diagnostic assessment score assay provided a definitive identification of anthracosis without any doubt leading to a final definitive and accurate diagnosis in all our patients. Although the diagnostic

evaluation analysis can not lead to an accurate final identification of anthracosis by itself in an occasional patient, it may elicit an accurate pathway for a detailed differential diagnosis.

Clinical manifestations of anthracosis	Index score
Absence of granulomatous infection, inflammation, or drug treatment	1
Patient history	2
Biomass or occupational exposure	2
Smoking	1
Lack of other lung diseases	1
Exclusive lung confinement	1
Dry cough and/or dyspnea	1
Absence of finger clubbing	2
Wheeze, rales, or decreased breath sounds	1
Laboratory findings	1
Obstructive pulmonary function	1
Chest x-ray findings	1
Thorax CT manifestations	2
PET/CT	2
Mass lesions or nodules	1
Lymphadenopathy	1
Bronchoscopy	4
Compatible histopathology	5

Table 1*: Assessment score analysis for anthracosis diagnosis based on clinicial manifestations.*

Pulmonary function tests: Mild or moderate obstructive lung function pattern.

Laboratoy: Increased ESR and/or CRP.

Chest-x ray: Fibrotic lesions, nodules, mass, decreased lung volume, atelectasis, and increased lucency.

Thorax CT: Decreased lung volume, fibrotic lesions, increased lucency, nodules, mass lesions, and atelectasis.

PET/CT: Inflammatory pattern.

Bronchoscopy: Black mucosal pigmentation, segmental obliteration, increased mucosal folds, and inflammatory changes.

Pathology: CD^{68} positive anthracotic macrophages in clusters or singly dispersed, fine anthracotic pigment, and absence of necrosis or atypical cells.

Diagnostic assessment score	Anthracosis diagnosis probability
DAS<8	Inconsistent
8≤ DAS<16	Low
16 ≤ DAS<24	Intermediate
DAS ≥24	Definite

Table 2: *Diagnostic probability of anthracosis.*

DAS: Diagnostic Assessment Score.

Conclusion

Anthracosis may occasionally appear as a challenge for clinicians that necesisates the assessment for other diseases in differential diagnosis like malignancy, infection, tuberculosis, and granulomatous inflammation. Such a clinical profile or occurrence exclusively comes out in the absence of characteristic clinical, radiological, bronchoscopic, and pathological manifestations of anthracosis. Consequently, diagnosis becomes exceptional in these patients leading to a clinical profile to exclude an extremely wide number of probable diseases. Imaging modalities including advanced procedures like CT or PET/CT may display equivocal findings to discriminate malignancy, infection, or granulomatous inflammation. The assessment assay we have set forth will not only provide a definitive diagnosis in many patients with equivocal clinical manifestations but will also provide an accurate pathway by ruling out other disease in cases where anthracosis has not been precisely identified. Appraisal of all individual patient data related to anthracosis in the assessment score analysis along with an integrated approach appears as the distinctive hallmark in reaching an accurate diagnosis. The analytical approach we set forth may be an extremely useful guide for clinicians, exclusively for uncertain or equivocal cases of anthracosis.

Author Contributions

Cuneyt Tetikkurt wrote the review.

Nejdiye Güngördü designed the imaging findings of the patients.

Mert Savcı constructed the bronchoscopic findings.

Enes Furkan prepared the laboratory and pulmonary function test results.

Conflicts of Interest

Cuneyt Tetikkurt does not have any conflicts of interest to declare relevant to this review.

Nejdiye Güngördü does not have any conflicts of interest to declare relevant to this review.

Mert Savcı does not have any conflicts of interest associated with this review.

Enes Furkan not have any conflicts of interest concerning this review.

Bibliography

1. Kim MH., *et al*. "The Clinical Significance of Bronchial Anthracofibrosis Associated with Coal Workers' Pneumoconiosis". *Tuberculosis and Respiratory Diseases* 68.2 (2010): 67-73.
2. Hwang J., *et al*. "Bronchial anthracofibrosis and tuberculosis in immigrants to Canada from the Indian subcontinent". *The International Journal of Tuberculosis and Lung Disease* 14.2 (2010): 231-237.
3. Wynn GJ., *et al*. "Anthracofibrosis, bronchial stenosis with overlying anthracotic mucosa: possibly a new occupational lung disorder: a series of seven cases from one UK hospital". *Chest* 134.5 (2008): 1069-1073.
4. Ribeiro C., *et al*. "The black bronchoscopy": a case of airway soot deposition". *Journal of Bronchology and Interventional Pulmonology* 20.3 (2013): 271-273.
5. Mirsadraee M and Saeedi P. "Anthracosis of lung; Evaluation of potential causes". *Journal of Bronchology and Interventional Pulmonology* 12 (2005): 84-87.
6. Kim YJ., *et al*. "Biomass smoke induced bronchial anthracofibrosis: presenting features and clinical course". *Respiratory Medicine* 103.5 (2009): 757-765.

7. Gupta A and Shah A. "Bronchial anthracofibrosis: an emerging pulmonary disease due to biomass fuel exposure". *The International Journal of Tuberculosis and Lung Disease* 15.5 (2011): 602-612.

8. Kim HY., *et al*. "Bronchial anthracofibrosis (inflammatory bronchial stenosis with anthracotic pigmentation): CT findings". *American Journal of Roentgenology* 174.2 (2000): 523-527.

9. Chung MP., *et al*. "Bronchial stenosis due to anthracofibrosis". *Chest* 113.2 (1998): 344-350.

10. Kim YJ., *et al*. "Biomass smoke induced bronchial anthracofibrosis: presenting features and clinical course". *Respiratory Medicine* 103.5 (2009): 757-765.

11. Mireles-Cabodevila E., *et al*. "Anthracostenosis". *The Egyptian Journal of Bronchology* 13 (2006): 153-155.

12. Mirsadraee M and Saeedi P. "Anthracosis of lung; Evaluation of potential causes". *Journal of Bronchology and Interventional Pulmonology* 12 (2005): 84-87.

13. Sigari N and Mohammadi S. "Anthracosis and anthracofibrosis". *Saudi Medical Journal* 30.8 (2009): 1063-1066.

14. Mirsadraee M., *et al*. "Bronchial anthracosis: a new diagnosis for benign mass lesions of the lung". *Tanaffos* 12.4 (2013): 10-18.

15. Lee HS., *et al*. "Clinical Features of Simple Bronchial Anthracofibrosis which is not Associated with Tuberculosis". *Tuberculosis and Respiratory Diseases* 53.5 (2002): 510-518.

16. Ryu DS., *et al*. "Anthracofibrosis Mimicking Lung Cancer on CT: MR Imaging Findings". *Journal of the Korean Society of Magnetic Resonance in Medicine* 5.1 (2001): 18-23.

17. Cheng NM., *et al*. "False positive F-18 FDG PET/CT in neck and mediastinum lymph nodes due to anthracosis in a buccal cancer patient". *Clinical Nuclear Medicine* 36.10 (2011): 963-964.

18. Hewitt RJ., *et al*. "Primary nodal anthracosis identified by EBUS-TBNA as a cause of FDG PET/CT positive mediastinal lymphadenopathy". *Respiratory Medicine Case Reports* 10 (2013): 48-52.

19. Amoli K. "Anthracotic airways disease: report of 102 cases". *Tanaffos* 8.1 (2009): 14-22.

20. Murty DA and Das DK. "Pulmonary tuberculosis with anthracosis: an unusual diagnosis by fine needle aspiration cytology". *Acta Cytologica* 37.4 (1993): 639-640.

21. Grobbelaar JP and Bateman ED. "Hut lung: a domestically acquired pneumoconiosis of mixed aetiology in rural women". *Thorax* 46.5 (1991): 334-340.

22. Na JO., *et al*. "Detection of Mycobacterium Tuberculosis in Bronchial Specimens Using a Polymerase Chain Reaction in Patients with Bronchial Anthracofibrosis". *Tuberculosis and Respiratory Diseases* 53.2 (2002): 161-172.

23. Amoli K. "Bronchopulmonary disease in Iranian housewives chronically exposed to indoor smoke". *European Respiratory Journal* 11.3 (1998): 659-663.

24. https://www.pathologyoutlines.com/topic/lymphnodesanthracosis.html

25. Zhai LY and Yu WC. "The Co-Occurrence of Anthracosis with Interstitial Lung Disease". *Sarcoidosis, Vasculitis and Diffuse Lung Diseases* 39.2 (2022): 1-9.

26. Takeda A., *et al*. "Altered lymphatic structure and function in pleural anthracosis: negative role in skip N2 metastasis". *European Journal of Cardio-Thoracic Surgery* 62.3 (2022): ezac123.

Volume 6 Issue 7 July 2023