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Editorial

Bronchial Anthracofibrosis: A Perilous Consequence of Exposure to Biomass Fuel Smoke

The term "anthracosis", coined in 1813 by Pearson,[1] refers to the bluish-black discolouration of the bronchial mucosa due to inhalation of soot. The majority of those affected include coal workers, cigarette smokers and city dwellers. It is often an incidental finding seen on bronchoscopy and is due to the deposition of carbon as well as other mineral elements, such as iron, lead and cadmium.

In 1951, Abraham Cohen[2] described narrowing of the middle lobe in eight female patients due to perforated tuberculous lymph nodes. Of these eight patients, six had anthracotic pigmentation in the right middle lobe. This was the first ever description of what is now termed as "bronchial anthracofibrosis (BAF)". This term was coined by Chung *et al*[3] from Korea to highlight bronchoscopically visible anthracotic pigmentation associated with narrowing or obliteration of the bronchi. The authors observed this phenomenon in 28 elderly subjects of whom 20 were females having a significant wood smoke exposure, and characterised the disease entity. Among these, three-fourths had right middle lobe involvement with active tuberculosis seen in 61%. Endobronchial and lymph node tuberculosis were postulated as causative factors and it was recommended that active tuberculosis must always be ruled out in a patient with BAF. The authors even advocated the prompt institution of empirical anti-tuberculous treatment in all such patients, regardless of bacteriological confirmation. This notion has now been replaced and a mounting body of evidence has emerged to implicate biomass fuel smoke exposure as the major incriminating factor.

It is estimated that nearly half the world's population, especially in the developing countries, is dependent on biomass fuel for cooking, heating and lighting their homes.[4] The common substances burnt are wood, charcoal, animal dung and crop wastes. Incomplete combustion of biomass fuel releases smoke containing nearly 200 compounds and gaseous pollutants along with solid particulate matter (PM 10 and PM 2.5).[5] The problem is compounded by the fact that, in developing countries, cooking is often done in closed confines without a separate kitchen and with very poor ventilation. These houses often have a combined living and kitchen area and smoke is frequently seen lining the ceilings and walls in the form of blackish soot deposition.

The two most important respirable particulate matter include PM 10 and PM 2.5. These particles are easily inhaled, bypass the pulmonary defense mechanisms and deposit deep within the lungs. The deleterious effects of biomass fuel smoke exposure includes neutrophilic inflammation, upregulation and deposition of fibronectin, lowered levels of pulmonary surfactant and oxidative stress leading to DNA (deoxyribonucleic acid) damage. In addition to this, exposure to biomass smoke leads to macrophagic dysfunction, reduced mucociliary mobility culminating in impaired immune response and significant decline in pulmonary functions.[5]

The National Family Health Survey-3 of India (2005–2006),[6] reported that 89% of the rural households and 22% of the urban population used biomass fuel for cooking. The survey also revealed that 74% of the households cooked their meals within their homes and 32% lacked a separate kitchen. The National Sample Survey of India (2009-10),[7] recorded that 76% of the population in the rural areas and 18% of the urban households were dependent on firewood for cooking. The World Health Organisation 2012 report[8] estimated that, in 2010, 58% of the Indian population was still dependent on biomass fuel as a medium for cooking.

The data from India presents an alarming picture with 500,000 deaths attributed to biomass fuel smoke exposure in 2000.[9] The effect of biomass smoke on the respiratory system is different in adults and children. In children, it leads to a reduced lung growth and acute respiratory infections; while in adults, chronic obstructive pulmonary disease (COPD), asthma, interstitial lung diseases, respiratory tract infections, tuberculosis, lung cancer and cardiovascular diseases are the known hazards of biomass fuel smoke exposure.[10] To this list of diseases due to biomass fuel smoke exposure, BAF has now been added and has emerged as a significant challenge.[3,11]

Bronchial anthracofibrosis was first recognised in India in a 65-year-old female with a history of wood-smoke exposure who presented with a middle lobe syndrome. Fibreoptic bronchoscopy not only revealed anthracotic pigmentation with narrowing of the middle lobe bronchus but *Mycobacterium tuberculosis* was also cultured from the bronchial aspirate.[12] A review of the literature reveals that this condition is predominantly seen in elderly non-smoking females with long standing history of exposure to biomass fuel smoke. These patients are generally from rural background and have cooked for long in indoors on traditional *chulhas* in poorly ventilated areas.[11] A study from Canada[13] revealed that BAF associated with pulmonary tuberculosis was more likely to develop in immigrants from the Indian sub-continent (50%) as compared to those from other Asian countries (3.7%).

The diagnostic clues that are seen on imaging can be pivotal for the diagnosis of BAF. The disease has a

"picturesque" radiological presentation with the chest radiograph being abnormal in majority of patients. The findings on plain chest radiograph include atelectasis, consolidation, bronchial wall thickening or narrowing, linear shadows, reticular or reticulonodular pattern and mass lesions.[14] However, the characteristic multifocal nature of bronchial stenosis visible on high resolution computed tomography (HRCT) of the chest often suggests the diagnosis of BAF. Other findings include atelectasis distal to the smoothly narrowed bronchus, multifocal peribronchial cuffing or bronchial wall thickening, mediastinal / hilar lymphadenopathy, consolidation, mass lesions and pleural abnormalities.[3,15,16]

Bronchial anthracofibrosis can only be confirmed on bronchoscopy. The most important findings are visible multiple bluish-black pigmented anthracotic lesions associated with bronchial stenosis. Anthracosis frequently involves the mucosa around the branching points of the bronchus in both the upper lobes and especially in the right middle lobe.[3,17] Stenosis of the involved bronchi is not infrequent. The diagnostic criteria for BAF which has evolved includes: (1) long standing history of biomass fuel smoke exposure, (2) multifocal nature of bronchial stenosis on HRCT chest and (3) confirmed bronchoscopically by (a) visible anthracotic pigmentation along with (b) narrowing / obliteration of bronchi.[3,11]

Clinical conditions usually associated with BAF include tuberculosis, pneumonia, COPD and malignancy.[11] Biomass fuel smoke exposure is an inherent risk factor for COPD[18] and BAF.[11] The diagnosis in a majority of patients would remain confined to COPD, if further evaluation for BAF was not done.[11] Once thought to be the causative agent of BAF, tuberculosis is now considered as an associated condition and is seen in 30% of patients with BAF.[11,19] The reasons postulated for the high prevalence of tuberculosis in BAF include effect of biomass fuel smoke on the activity of pulmonary macrophages, higher prevalence of tuberculosis in elderly, decreased immune response in the elderly and increased sensitivity to *M. tuberculosis* due to silica containing pigmentation.[11] It is also thought that in those with significant biomass fuel smoke exposure, there is a greater risk of tuberculosis.[20,21] A significant association exits between occurrence of endobronchial tuberculosis and BAF. Endobronchial tuberculosis usually involves a single lobar bronchus with contiguous spread along the bronchus leading to bronchostenosis similar to that seen in BAF. Endobronchial tuberculosis was seen in 16% of patients with BAF with the ulcerative variant being the most common.[22] Pneumonia is a common association in patients with BAF and majority of consolidations are seen in lobes having bronchial narrowing. The structural abnormality of the bronchus is the major predisposing factor for the development of pneumonia in these patients.[11] Since biomass fuel smoke exposure is associated with increased risk of lung cancer and COPD, BAF, which shares this risk factor, could possibly be associated with increased risk of malignancy as well.[11]

The recognition of BAF as a distinct clinical entity once again highlights the grave dangers posed by long standing exposure to biomass fuel smoke. Although it was first reported from Korea less than two decades ago, a vast majority of cases have been reported from Iran and Turkey. In developing countries, there is a definitive lack of awareness, not only in the general population but also among clinicians. A diagnosis of BAF should always be suspected in elderly females from a rural background with a significant history of biomass fuel smoke exposure in poorly ventilated kitchens. Since BAF can only be confirmed on bronchoscopy, there is a need to develop non-invasive diagnostic modalities for its early recognition. Furthermore, treatment strategies have to be evolved. It is imperative that a sustained campaign be started by the government as well as the medical fraternity to highlight the perils of exposure to biomass fuel smoke. There is an urgent need to develop preventive measures and technologies for cleaner and greener forms of energy so as to lessen the dependence of the rural population on biomass fuel.

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