Original Article

Prevalence of Tuberculosis in Patients with Anthracosis: Study on 150 Subjects

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Abstract

Background: A probable concordance and association between pulmonary tuberculosis and anthracosis was observed in the published literature. We conducted this study to evaluate the clinical and radiologic characteristics of patients with bronchoscopic evidence of anthracosis as well as the prevalence of pulmonary tuberculosis in patients with anthracosis.

Methods: Included in the study were 150 consecutive patients with evidence of anthracosis as evidenced by bronchoscopy. Pulmonary tuberculosis diagnostic work up which included bronchoalveolar lavage, sputum smears and cultures, or histologic examination of lung biopsies was performed on all patients. Patients' clinical, pathological, and radiological findings were also recorded and analyzed.

Results: A total of 88 men and 62 women, ranging in age from 42 to 92 years were included in the study. Dyspnea (38.7%) and productive cough (35.3%) were among the most common chief complaints. The abnormal bronchoscopic findings were seen most frequently in the right middle lobe bronchus. In 42 patients pulmonary tuberculosis was confirmed either bacteriologically (n = 32) or histologically (n = 10). CT scans of 26 patients were examined, of which the most frequent findings were consolidation and a reticular pattern. Pleural involvement was observed in 14 patients.

Conclusion: Prevalence of pulmonary tuberculosis was higher among those with bronchial stenosis ($P < 0.05$). These findings have suggested that bronchial anthracosis, especially cases of localized anthracosis, in patients with bronchial stenosis and in those without a history of smoking or occupational exposure may be caused by tuberculosis.

Keywords: Anthracosis, bronchoscopy, tuberculosis

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Introduction

Anthracosis is defined as deposition of coal and other black pigments in the bronchial tree.[1] Anthracosis is predominantly composed of carbon and traces of other substances, such as silica and iron.[1] This term was first described in coal miners. After civilization and industrialization of countries it was increasingly reported in residents of industrialized societies.[2]

It is hypothesized that inhalation of dust, carbon, silica and other small mineral particles are among the predisposing factors of anthracosis;[3] however, the inhalation hypothesis could not explain the mechanism of observed localized anthracosis. There are also reports of anthracosis without histories of occupational exposures or smoking. A concordance and association between pulmonary tuberculosis and anthracosis is present in published studies.[4–6]

It is hypothesized that pulmonary tuberculosis could explain localized anthracosis and anthracosis in patients without a history of smoking or occupational exposure.[7]

There are additional theories that attempt to explain the high prevalence of pulmonary tuberculosis in patients with anthracosis as an impaired function of macrophages due to implantation of silica particles.[8]

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We conducted this study to evaluate the clinical and radiologic characteristics of patients with bronchoscopic evidence of anthracosis as well as the prevalence of pulmonary tuberculosis in patients with anthracosis.

Materials and Methods

Methods

A total of 150 consecutive patients with evidence of anthracosis as evidenced by bronchoscopy were included in the study. All patients underwent pulmonary tuberculosis diagnostic work up that included bronchoalveolar lavage (BAL), sputum smears and cultures, or histologic examination of lung biopsies. Patients' clinical, pathological, and radiological findings were also recorded and analyzed.

The study aims and risks were explained for all patients included in the study and written informed consents were obtained. The study protocol was reviewed and approved by the Tehran University of Medical Sciences Ethics Committee.

Patients

Consecutive cooperative patients aged more than 18 years, with evidences of anthracosis during fiberoptic bronchoscopy were enrolled in the study. Immunodeficient patients, patients treated with immunosuppressive agents, patients with malignancies and those with evidence of fungal infection in the lungs were excluded from the study. Malignancy was excluded by extensive evaluation in all patients. Patients with primary diagnosis of tuberculosis were also excluded from the study.

Table 1. Comparison of clinical symptoms in two groups of tuberculosis positive and negative patients

	Cough	Dyspnea	Productive Cough	Non- pulmonary	Total
Tuberculosis negative	24 (22.2%)	46 (42.6%)	33 (30.6%)	5 (4.6%)	108
Tuberculosis positive	7 (16.7%)	12 (28.6%)	20 (47.6%)	3 (7.1%)	42
Total	**31**	**58**	**53**	**8**	**150**

Table 2. Prevalence of anthracosis, percentages of patients with anthracosis, and tuberculosis prevalence in patients with and without anthracosis in recent published studies in Iran

	Anthracosis (%)	Men/women	Tb with anthracosis	Tb without anthracosis
Ghanei et al.	7.7%	45.8%/54.2%	57.8%	10.6%
Samareh Fekri et al.	20%	44.4%/55.6%	6.9%	2.7%
Rezaitalab et al.	22.5%	41%/59%	23.5%	10.6%
Mirsadraee et al.	21%	50%/50%	30%	N.R.*

*N.R.: Not reported;

Procedure

All patients were intravenously sedated with an opiate (fentanyl) and/or short acting benzodiazepine (midazolam); lidocaine was also administered with inhalation and instillation during bronchoscopy for local anesthesia.

Electrocardiography, continuous blood pressure monitoring and pulse oximetry were performed before, during and three hours after bronchoscopy. Arterial blood gas analysis was also performed before and after bronchoscopy.

Under the above conditions, patients underwent bronchoscopy. During bronchoscopy, patients received oxygen via masks or cannulas. After identification of anthracosis, the bronchoalveolar lavage was obtained. Biopsies were also obtained in selected patients if indicated. After bronchoscopy, sputum samples in patients with sputum were also examined for acid-fast bacilli. Conventional chest Computerized Tomography (CT) was also obtained in 26 patients.

Pathology

Diagnosis of pulmonary tuberculosis was confirmed by the presence of acid-fast bacilli in either sputum smear or culture (sputum samples were obtained after bronchoscopy in the patients with productive cough), BAL or histologic examination of obtained biopsies.

Statistical analysis

Chi square test was used to assess the significance of differences. Statistical Package for the Social Sciences, Version 16.0, (SPSS Inc. Chicago, IL, USA) was used for all statistical analyses. The significance of difference was set at 0.05.

Results

Included in the study were 88 men (58.7%) and 62 women (41.3%), whose ages ranged from 42 to 92 years (mean age 72.3 years). Of these, 58 (38.7%) had dyspnea on exertion and 53 (35.3%) complained of cough with variable amounts of sputum. In 31 patients (20.7%), dry cough without sputum was the main symptom. There were 8 patients who had non-pulmonary complaints; among them, 3 were referred because of ascites, 2 had cardiac tamponade, and 3 complained of systemic symptoms such as fever and weight loss (Table 1).

Smokers comprised 58 patients of the study population, whereas 11 reported occupational exposure to coal dust and 4 were bakers. Totally, 35 patients had exposure to wood-smoke as fuel for cooking, 9 had active tuberculosis, 3 were smokers, and 1 reported a history of close contact with a tuberculosis-infected patient. On the other hand, 22 patients only had chronic exposure to indoor smoke in the past.

In 42 patients pulmonary tuberculosis was confirmed either bacteriologically (n = 32) or histologically (n = 10). Sputum smears were positive for acid-fast bacilli in 10 patients and BAL smears were positive for acid-fast bacilli in 17 patients. In 5 patients, the diagnosis was made by cultures of sputum or bronchial washing fluid. In another 10 patients without bacteriologic documentation of tuberculosis, pathologic examination of the pleural or bronchoscopic biopsy specimens showed chronic granulomatous inflammation consistent with tuberculosis.

Close contact with tuberculosis-infected patients in the past was noted in 16 patients in whom 12 had active tuberculosis at the time of our study. This association was significant at $P < 0.05$.

The principal finding of bronchoscopy was anthracotic pigmentation of bronchial mucosa. In 55 patients there was also narrowing and deformity of the airways. In these patients, the prevalence of tuberculosis was significantly higher than those without narrowing and deformity (43% vs. 19%; $P < 0.05$).

Bronchi of the right lung were more frequently affected than those of the left lung. In 83 patients, anthracosis was seen in both lungs. The right middle lobe bronchus was the most frequently involved, followed by the left upper lobe bronchus and the right upper lobe bronchus. Although in tuberculosis-infected patients the second site after the right middle lobe bronchus was the right upper lobe bronchus; this difference was not statistically significant.

Conventional CT was performed in 26 patients. The most frequent pattern of parenchymal involvement was consolidation (alveolar: 46.2%) followed by reticular (34.6%) and nodular (11.5%). In two patients, chest CT-scans were within normal limits. None of them had tuberculosis. Segmental or subsegmental atelectasis was noted in 10 patients. Also, 4 subjects showed mediastinal or hilar lymphadenopathy on their CT scans. The most frequent site of involvement was the right middle lobe followed by the right upper lobe. In 14 cases, pleural involvement (thickening, effusion or both) was remarkable on the CT scans; of these, tuberculosis was confirmed in 11 patients (78.6%). The prevalence of tuberculosis in 10 patients without pleural involvement was 10%, which was statistically significant ($P < 0.05$).

It must be emphasized that in patients with tuberculous infection, anthracosis was localized rather than diffused with a tendency for contiguous involvement of the bronchial tree ($P < 0.05$).

Ultimately, in our study there was no difference between rural and urban residency.

Discussion

According to the results of our study, a high prevalence of pulmonary tuberculosis was observed in patients with anthracosis. It was in accordance with other published studies.[3–7] The prevalence of pulmonary tuberculosis in patients with anthracosis has ranged between 6.9% and 57.8% in previously published studies in Iran (Table 2).[4,5]

Although pulmonary tuberculosis is one of the oldest known diseases, it is still one of the most important health problems worldwide. In recent years, the prevalence of tuberculosis has increased due to Human Immunodeficiency Virus (HIV) infection.[9] Unfortunately, the diagnosis of pulmonary tuberculosis is difficult in some cases because of the dubious character of tuberculosis.[4,9] As pulmonary tuberculosis may cause wheezing, it has been shown that it may be misdiagnosed as bronchial asthma.[10,11] These patients may be mistakenly treated for asthma for long periods of time.

In our study, the prevalence of pulmonary tuberculosis increased in patients with localized anthracosis and in the presence of bronchial deformity and narrowing (43%). A concordance and association between pulmonary tuberculosis and anthracosis was also noticed in published studies.[4,5] The risk of tuberculosis in people with anthracosis was 2.6 times greater than healthy subjects in a study by Samareh Fekri et al. (95% CI: 1.48 – 4.75).[5] Ghanei et al., in a recent published study, have reported the history of tuberculosis as a probable effective factor on anthracosis (OR = 8.63, $P < 0.001$).[4]

There are different theories that have attempted to explain the mechanism of anthracosis and high prevalence of tuberculosis in these patients.

The silicosis theory has explained the high prevalence of pulmonary tuberculosis in patients with anthracosis with impaired alveolar macrophage function as a result of silica implantation in macrophages and a reduction in the body's tolerance against *Mycobacterium tuberculosis*. This implies that anthracosis is the predisposing factor for pulmonary tuberculosis.[8]

Inhalation of dust, carbon, silica, and other small mineral particles are among the predisposing factors for anthracosis; however, the inhalation hypothesis could not explain the mechanism of observed localized anthracosis.[6,7] There are reports of anthracosis in patients with no histories of occupational exposures or smoking. It is hypothesized that pulmonary tuberculosis could explain localized anthracosis, as well as anthracosis in patients without histories of smoking or occupational exposure.[6,7,12] Additionally, this theory could explain the high prevalence of pulmonary tuberculosis in patients with anthracosis. In this theory pulmonary tuberculosis is the predisposing factor for anthracosis. Opening of tuberculosis-infected lymph nodes to the bronchial space could explain localized anthracosis and bronchial stenosis.[7]

In this study, 22 patients mentioned chronic exposure to indoor smoke in their histories; all had widespread anthracotic involvement as seen in their bronchoscopic examinations. This has implied that a positive history of chronic exposure to indoor smoke can be presumed to be a probable cause of anthracosis; especially in patients with diffused rather than localized involvement.

Other characteristic features of the patients in our study were as follows: 1) the chief complaint of dyspnea in total, but a preponderance of cough and sputum in tuberculosis-infected patients; 2) positive association of anthracosis with occupational exposure to coal dust and indoor inhalation of woodsmoke; 3) segmental or lobar consolidation on CT scans with a significantly higher rate of pleural abnormalities in tuberculosis-infected patients; and 4) most frequent involvement of the right middle lobe bronchus.

The prevalence of anthracosis in men was more than women in our study. This contradicted the results of other published studies in Iran.[4–6] A higher prevalence of anthracosis in women was reported in other similar published studies in Iran (range: 50% – 58.8%; Table 2).[2,7] Ghanei et al. in a recent published study, reported the female gender as a probable effective factor on anthracosis (OR = 2.17, $P < 0.001$).[4] According to the results of the Samareh Fekri et al. study, the prevalence of anthracosis in men were 0.4 times less than those in women (95%CI: 0.32 – 0.52; $P < 0.001$).[5]

The mean age of patients in our study was 72.3 years, which was in accordance with the results of other studies. This has shown anthracosis to be a disease of elderly individuals. According to the results of a later similar published study, each year increase in age could lead to a 1.07% increased risk of developing anthracosis among lung-affected patients.[4]

Ultimately in our study there was no difference between rural and urban residency. This may be biased data, because this study was conducted in a referral medical center where the study population was not randomly selected from rural and urban residents.

Unfortunately the total performed bronchoscopies and total prevalence of pulmonary tuberculosis in our patients were not recorded in our center; thus, we were unable to make a logistic regression test in order to evaluate the association of pulmonary tuberculosis and anthracosis. This was the main limitation of this study.

According to the results of our study, pulmonary tuberculosis was diagnosed in 28% of patients with anthracosis. The prevalence of pulmonary tuberculosis significantly increased in patients with bronchial stenosis ($P < 0.05$). These findings have suggested that bronchial anthracosis, particularly in cases of localized anthracosis, as seen in patients with bronchial stenosis and those without history of smoking or occupational exposure may be caused by tuberculosis.

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