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ORIGINAL RESEARCH

Antimoniosis: Radiological Insights into a Rare Pneumoconiosis in Miners

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Aim: Pneumoconiosis describes diseases caused by the accumulation of inorganic dust particles in the lungs, leading to tissue damage. The diagnosis relies on a history of exposure and compatible radiological findings.

Background: We aimed to investigate the radiological findings in individuals exposed to antimony-inert dust relative to their working periods.

Objective: Fifty-six symptomatic male antimony miners were retrospectively evaluated for demographics and chest computed tomography (CT) scans.

Methods: The demographic and radiological data of patients with a history of antimony mining, who presented at our pulmonary clinic between June 2017 and June 2023, were analyzed according to the duration of exposure.

Results: The study included 56 male patients with a mean age of 58.5±13.02 years and a mean exposure duration of 13.63 ± 6.82 years. CT scans showed that 73.2% (n=41) had upper and middle lung zone involvement, and 55.4% (n=31) had extensive involvement. Micronodules with centriacinar ground-glass opacities were the most common finding (n=37, 66.1%), followed by nodular opacities with irregular margins (n=22, 39.3%) and solid micronodules (n=20, 35.7%). Patients with over 20 years of exposure had significantly higher rates of respiratory and cardiovascular disease ($p<0.05$). Increased exposure time correlated with more extensive parenchymal involvement and higher rates of calcification in mediastinal lymph nodes, solid micronodules, nodular opacities with irregular margins, honeycombing, and conglomerate mass appearance.

Conclusion: Radiological findings in pneumoconiosis generally worsen with longer exposure. Given the scarcity of up-to-date information on antimony pneumoconiosis, further studies focusing on radiological findings and chemical analyses of those exposed to antimony mine dust are essential to identify related pathologies.

Keywords: rare lung diseases, antimony, pneumoconiosis, computerized thorax tomography, ground-glass opacities, lymph nodes

Introduction

Pneumoconiosis is the accumulation of inorganic dust in the lungs and the tissue response to it. It occurs as a result of continuous and intense exposure to dust in some sectors, particularly in confined and poorly ventilated environments.[1] There are dozens of diseases, such as coal workers' pneumoconiosis, silicosis, asbestosis and siderosis.[2] Occupational exposure to antimony and its compounds can cause pulmonary toxicity. However, it is not a common form of pneumoconiosis and its carcinogenic effects have not been observed in humans.[3]

Antimony (*Sb*) is a mineral that occurs naturally in the earth's crust at a concentration of approximately 0.2–0.3 mg/kg (*ppm*).[4] In addition, antimony and its compounds are among the oldest known medicines in medical practice and have been used for the treatment of a variety of diseases for the last 600 years. It is mainly extracted from the ores of sulphide minerals.[5] Many industries, such as steel, paint and electronics, still use antimony.[6] It appears to be a benign process similar to that seen in siderosis, stannosis and barytosis, in which effects on the upper and lower respiratory tract have been previously reported in relation to the severity, concentration and duration of the respiratory effects.[7]

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Despite the well-documented effects of various types of pneumoconiosis, antimoniosis remains a relatively under-explored condition, particularly in relation to its radiological characteristics. This study is novel in its detailed examination of thoracic CT findings among antimony miners, offering new insights into the progression and presentation of this rare pneumoconiosis. To our knowledge, this is one of the few studies that specifically focuses on the radiological patterns of antimoniosis using modern imaging techniques, contributing significantly to the limited existing literature on the subject.

Materials and Methods

The demographic data, exposure times, and computed tomography findings of 56 patients who presented to our chest disease clinic with respiratory symptoms and a history of working in the antimony mine between July 2017 and 2022 were retrospectively evaluated. All patients had a history of working in the opening and excavation, transport and loading, crushing and grinding of the antimony mine. Involvement of more than two lobes was defined as diffuse, and radiological findings related to antimony mining were divided into four groups according to the duration of exposure. This study was approved by Gaziosmanpasa University Clinical Research Ethics Committee (Project No: 22-KAEK-160, approval date: 11/08/2022). As patient consent to review their medical records was not required by the Gaziosmanpasa University Clinical Research Ethics Committee due to the retrospective design of the study, the data was anonymized to ensure patient confidentiality, and all procedures were conducted in compliance with the Declaration of Helsinki.

Statistical Analysis

Data analyses were performed using SPSS for Windows, version 22.0 *(SPSS Inc., Chicago, IL, United States)*. Continuous data were described as mean±SD. Categorical data were described as a number of cases *(%)*. Categorical variables were compared using *Pearson's Chi-square test or Fisher's* exact test was accepted with *p-value <0.05* as a significant level on all statistical analyses.

Results

The mean duration of exposure to antimony dust was 13.63±6.82 years in 56 antimony miners with a mean age of 58.5 ±13.02 years. Of the 19 (33.9%) workers, none had ever smoked and none had a history of tuberculosis. In all patients, at least one chronic respiratory disease (n=19, 33.9%), including asthma and chronic obstructive pulmonary disease, was the most common, followed by a history of cardiovascular disease in 12 (21.4%) patients, widespread diffuse involvement in 31 (55.4%) patients, and the most common involvement was the upper-middle zone (n=41, 73.2%). Besides the detection of calcific mediastinal lymphadenopathy in 26 (46.4%) patients, the most common findings were 66.1% (n=37) centriacinar ground-glass micronodules in the parenchyma, 39. 3% (n=22) nodular opacities with irregular margins, solid micronodules 23.2% (n=13), pulmonary fibrosis 18.2% (n=13), conglomerate mass appearance 19.6% (n=11) and honeycomb appearance in 10 patients (17.9%) (Figure 1), no parenchymal involvement was observed in only 8 patients (14.3%) (Table 1).

According to exposure time, there was a statistically significant difference (*p<0.05*) between respiratory and cardiovascular diseases. Respiratory and cardiovascular disease rates were statistically higher in those with more than 20 years of exposure compared with other groups in four different groups according to exposure time (Table 2). With increasing exposure time, the prevalence of involvement, calcific mediastinal lymphadenopathy, solid micronodules, nodular opacities with irregular margins, honeycomb and conglomerate mass appearance forms of involvement was statistically significantly higher (Table 3).

Discussion

Pneumoconioses are as old as human civilization itself, with evidence of these occupational lung diseases dating back thousands of years.[8] Formed as a result of exposure to many organic and inorganic dust particles, they cause occupational disease throughout the world. Sb is naturally present in the earth's crust at a concentration of approximately 0.2–0.3 mg/kg (*ppm*) and its density varies according to the geographical region.[4,9] It is used for the hardening of iron alloys, diodes, cable coatings, lead acid batteries, plastics, various chemicals, ceramic enamels and glass. It is a mineral that has many

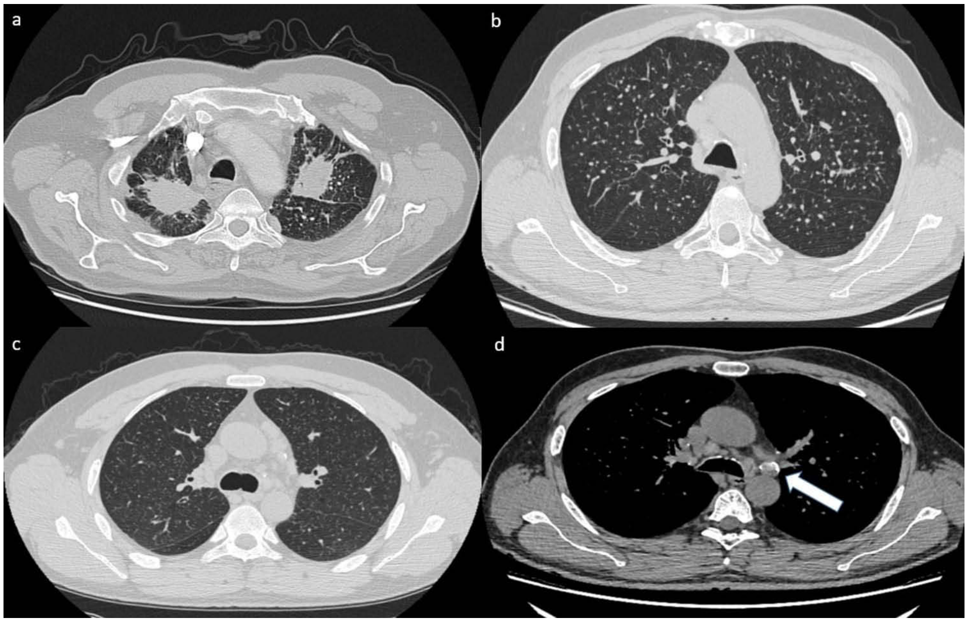

Figure 1 (**a**) Pulmonary fibrosis (**b**) Solid micronodules (**c**) Micronodules in the form of centriacinar ground glass density (**d**) White arrow: Calcified mediastinal lymph node.

uses in the dyeing and pharmaceutical industries and has been known since ancient times, perhaps as early as 4000 B.C.[10] The widespread use of antimony has led to the study of adverse effects that may be associated with occupational exposure. While *Sb* can cause pulmonary lesions and progressive loss of lung function in animals, the effects in humans often begin as benign fibrotic lesions, but these can, in some cases, progress from micronodules to macronodules, and

Table 1 Demographic, Exposure Time and Radiological Involvement Characteristics of the Patients

	(n=56)	(%)
Smoking		
Non-smoker	19	33,9%
Ex-smoker	9	16,1%
Smoking	28	50,0%
Smoking packages, $\overline{X} \pm SD$	14,61±16,73	
Comorbid Disease		
No	26	46,4%
Yes	30	53,6%
Respiratory System Disease	19	33,9%
Cardiovascular Disease	12	21,4%
Diabetes	9	16,1%
Extra thoracic malignancy	4	7,1%
Other	5	8,9%

(*Continued*)

Table 1 (Continued).

Exposure Time, $\overline{X} \pm SD$	13,63±6,82	
Exposure Times		
< 5 years	7	12,5%
5–10 years	11	19,6%
10–20 years	25	44,6%
>20 years	13	23,2%
Involvement Area		
None	8	14,3%
Superior – Middle zone	41	73,2%
Middle – Lower zone	2	3,6%
Lower zones zone	1	1,8%
All zones	4	7,1%
Involvement		
None	8	14,3%
Minimal	17	30,4%
Diffuse	31	55,4%
Mediastinal LAP		
Normal	30	53,6%
Calcific	26	46,4%
Parenchymal involvement patterns		
Micronodules of centriacinar ground glass density	37	66,1%
Nodular opacities with irregular margins	22	39,3%
Solid micronodules	20	35,7%
Pulmonary fibrosis	13	23,2%
Conglomerate mass appearance	11	19,6%
Honeycoming	10	17,9%

Abbreviation: LAP, Lymphadenopathy.

potentially to progressive massive fibrosis (PMF). However, the degree of progression can vary significantly among individuals.[11]

There are very few studies in the literature on the findings on chest radiographs (ILO classification) in *Sb*. There is a need for research describing the forms of involvement using computed tomography of the lungs. Karajović et al published a report describing a specific radiological finding of pneumoconiosis in people exposed to antimony oxide dust. In the study, pneumoconiosis changes were found in 17 (27.58%) of 62 subjects, p-type and less frequently m-type, categories 1–3 (ILO classification, Geneva, 1958). None of the subjects had massive fibrosis.[12] The study by Potkonjak et al examined 51 men aged 31 to 54 (mean 45±23) who had worked in an antimony factory for between 9 and 31 years (mean 17.91). In those exposed to antimony oxide dust for less than 9 years, no changes were observed. On the other

Table 2 Evaluation of Smoking, Additional Diseases and Findings According to Exposure Times

	Exposure Time								**p-value**
	< 5 years		**5–10 years**		**10–20 years**		**>20 years**		
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Smoking									0.679
Non-smoker	3	42,9%	2	18,2%	9	36,0%	5	38,5%	
Ex-smoker	-		3	27,3%	3	12,0%	3	23,1%	
Smoking	4	57,1%	6	54,5%	13	52,0%	5	38,5%	
Comorbid Disease									0.066
No	4	57,1%	7	63,6%	13	52,0%	2	15,4%	
Yes	3	42,9%	4	36,4%	12	48,0%	11	84,6%	
Findings									
Respiratory System Disease	-		3	27,3%	6	24,0%	10	76,9%	**0.001**
Cardiovascular Disease	1	14,3%	-		5	20,0%	6	46,2%	**0.049**
Diabetes	3	42,9%	1	9,1%	2	8,0%	3	23,1%	0.115
Extra thoracic malignancy	-		-		1	4,0%	3	23,1%	0.170
Other	-		1	9,1%	3	12,0%	1	7,7%	0.999

Note: Bolded p values denote significance (p<0.05).

Table 3 According to Exposure Time; Involved Zone, Extent of Involvement, Mediastinal LAP, Parenchymal and Forms of Involvement

	Exposure Time								**p-value**
	< 5 years		**5–10 years**		**10–20 years**		**>20 years**		
	n	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	
Involvement Area									**<0.001**
None	5	71,4%	2	18,2%	1	4,0%	-		
Superior – Middle zone	2	28,6%	8	72,7%	23	92,0%	8	61,5%	
Middle – Lower zone	-		1	9,1%	-		1	7,7%	
Lower zones	-		-		-		1	7,7%	
All zones	-		-		1	4,0%	3	23,1%	
Involvement									**<0.001**
None	5	(71,4%)	2	18,2%	1	4,0%	-		
Minimal	2	(28,6%)	4	36,4%	9	36,0%	2	15,4%	
Diffuse	-		5	45,5%	15	60,0%	11	84,6%	

(*Continued*)

Table 3 (Continued).

Mediastinal LAP									**0.002**
Normal	7	(100,0%)	9	81,8%	10	(40,0%)	4	(30,8%)	
Calcific	-		2	18,2%	15	(60,0%)	9	(69,2%)	
Parenchymal involvement patterns									
Centriaciner ground glass densities	2	(28,6%)	7	63,6%	21	84,0%	7	53,8%	**0.029**
Solid micronodules	-		3	27,3%	9	36,0%	8	61,5%	**0.046**
Pulmonary fibrosis	-		1	9,1%	6	24,0%	6	46,2%	0.084
Nodular opacities with irregular margins	-		1	9,1%	12	48,0%	9	69,2%	**0.002**
Honeycombing	-		-		3	12,0%	7	53,8%	**0.003**
Conglomerate mass appearance	-		-		3	12,0%	8	61,5%	**<0.001**

Note: Bolded p values denote significance (p <0.05).
Abbreviation: LAP, Lymphadenopathy.

hand, positive radiographic findings of antimoniosis were defined as the presence of diffuse, densely distributed, round or polygonal, irregularly shaped opacities, usually less than 10 mm in diameter, and they stated that they were concentrated in the middle lung areas There was statistically significant coverage of all zones (p<0.001) in the middle zone (73.2%) compared to the other groups. As the exposure time increased, there was a significant increase in the prevalence of involvement (p < 0.001).[7] Our study also detected calcific mediastinal lymph nodes, thought to be secondary to antimony dust exposure, which had not been identified in previous studies and which were thought to increase in incidence with increasing exposure time. Specifically, the incidence was 60.0% in patients with a history of exposure over 10 years, 10–20 years and >20 years. Calcifications in the mediastinal lymph nodes were found in 69.2% of cases.

It has been known for a long time that exposure of mammals to Sb-containing compounds is particularly dangerous to heart muscle cells in animal models, as Sb exposure causes benign pneumoconiosis.[13] The presence of calcific mediastinal lymph nodes and the increased prevalence of involvement as exposure time to antimony dust increases highlight the potential respiratory effects of long-term exposure to antimony oxide dust.[14] Long-term exposure to antimony oxide dust can lead to respiratory effects, including the presence of calcific mediastinal lymph nodes and an increased prevalence of pneumoconiosis.[15] These respiratory effects can have serious implications for individuals exposed to antimony oxide dust over extended periods of time, emphasizing the importance of implementing effective safety measures and regular health monitoring in industries where antimony oxide dust exposure is likely.[5] Brieger et al described electrocardiogram (ECG) changes in rats, rabbits and dogs exposed to airborne antimony dust. ECG changes were found in about 50% of workers who were also exposed.[16] Two studies did not find an association between exposure to antimony and disease of the heart or peripheral arteries.[17,18] Mendy et al reported that exposure to antimony dust was not associated with asthma in respiratory effects.[19] In our study, we found a statistically significant increase in respiratory and cardiovascular disease with a 20-year exposure history, independent of age. However, it is important to note that this subgroup consisted of only 13 subjects. The small sample size limits the robustness of these findings, and as such, they should be interpreted with caution.

Although the radiological patterns and characteristics of workers exposed to antimony dust have been defined in a few studies on the basis of the ILO classification in previous literature reviews, the focus of research has been on the investigation of the effects of the toxic effects of antimony mining in animal models. The existing literature primarily focuses on the toxic effects of antimony mining in animal models, rather than on the radiological patterns and characteristics of workers exposed to antimony dust.[20] Our study was the first to define computed tomography evaluation, and it was observed that the findings increased from mild to severe as a result of exposure times. The findings ranged from micronodules of centriacinar ground-glass density, to fibrosis and honeycomb appearance in some cases, to the appearance of conglomerate masses that could be confused with malignancy. This study provides a novel contribution to the understanding of antimoniosis, particularly through the detailed characterization of radiological findings in a specific occupational cohort. Unlike previous studies that primarily relied on chest X-rays, our use of thoracic CT imaging offers a more precise assessment of lung involvement, uncovering features such as honeycombing and nodular opacities that have not been extensively documented in antimoniosis. These findings not only enhance the current understanding of this rare form of pneumoconiosis but also lay the groundwork for future research aimed at establishing standardized imaging criteria for its diagnosis and management.

Given the small sample size in certain subgroups, particularly those with prolonged exposure, we recognize that the statistical power to draw definitive conclusions is limited. As such, while the observed trends provide valuable insights, these findings should be interpreted with caution, and further research with larger cohorts is necessary to confirm these results.

Conclusion

Antimony is an important chemical substance for industrial applications. However, it should be recognised as a substance that has the potential to be harmful to human health. Radiological information on antimony pneumoconiosis is scarce and not up to date, although many large-scale studies have clearly defined the toxic effects of antimony powder or its compounds on the human body and its effects on other systems. Therefore, in order to identify findings that may be caused by this dust and may be confused with other interstitial lung disease pathologies, it will be useful to study the data on lung radiological findings and the chemistry of antimony in humans. In addition, individuals working with antimony should take appropriate occupational safety measures and be aware of the health risks. There is also a need for further research into the effects of antimony on human health and the development of strategies to mitigate these risks.

Disclosure

The authors report no conflicts of interest in this work.

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