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Confronting the Silent Threat of Pneumoconiosis in Informal Mining: Two Case Reports and Literature Review

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Case Report

Keywords: Pneumoconiosis, artisanal miners, peri-mining communities, lung fibrosis

Posted Date: September 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10572273/v1

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Additional Declarations: No competing interests reported.

Abstract

Background: Pneumoconiosis poses a significant public health challenge among artisanal and small-scale miners due to inadequate prevention of workplace dust, delayed diagnosis, and limited treatment options. In tuberculosis-endemic settings, the disease is frequently mistaken for pulmonary tuberculosis, leading to inappropriate treatment and delayed recognition. Reports describing advanced pneumoconiosis among artisanal miners in Tanzania remain scarce despite the rapid expansion of informal mining. This report presents two fatal cases to highlight important diagnostic challenges, uncommon clinical manifestations, and lessons for clinical practice.

Case presentation: We describe two African men aged 30 and 34 years admitted to Katavi Referral Regional Hospital between December 2024 and March 2025 after 11 and 4 years of artisanal gold mining, respectively. Both presented with progressive dyspnea, chronic cough, hypoxemia, and marked weight loss and had initially been treated empirically for tuberculosis despite negative microbiological investigations. Chest computed tomography (CT) demonstrated progressive massive fibrosis consistent with complicated pneumoconiosis, while one patient had the uncommon finding of silica-associated constrictive pericarditis with pericardial calcification. Both patients received supportive treatment comprising oxygen therapy, corticosteroids, bronchodilators, antibiotics, and pulmonary rehabilitation; however, they developed progressive respiratory failure and died during hospitalization.

Clinical discussion: The reported cases illustrate that advanced pneumoconiosis may develop after relatively short occupational exposure, continue to progress even after mining exposure has ceased, and closely mimic pulmonary tuberculosis in high-burden settings. They also highlight the diagnostic value of obtaining a detailed occupational history and performing chest CT when tuberculosis investigations are negative or when patients fail to respond to treatment. Furthermore, the report documents a rare cardiovascular manifestation of constrictive pericarditis associated with silica exposure.

Conclusion: These cases contribute to the limited literature on pneumoconiosis among Tanzanian artisanal miners and underscore the need for early diagnosis through occupational history taking, timely chest evaluation, and strengthened occupational health surveillance to reduce diagnostic delays and prevent advanced disease.

Background

More than 100 million people in the world's population engage in mining activities globally [1]. Mining activities are categorized into three main types: large-scale, medium-scale, and small-scale operations. Small-scale mining [SSM] is regarded as informal mining, where miners receive inadequate financial support, deploy primitive and low-technology mechanisms, usually conducted by individual miners and family members [2]. In Tanzania, the number of SSM has increased from an estimated 150,000 in 1987 to 1.5 million in 2017, with most engaging in the mining of gold, construction materials, and gemstones [3]. Informal mining is the main source of employment in Central Africa (91.0%), Eastern Africa (91.6%), and Western Africa (92.4%) [4]. In practice, the problems of health and safety for artisanal miners have

increased notably due to direct involvement in manual labour, and inadequate protection and care both on and off-site [2]. Health threats such as pneumoconiosis, silicosis, and tuberculosis are common conditions occurring in informal mining, leading to a shortening of their lives [5]. However, the Southern African Development Community [SADC] reported a triple epidemic of HIV infection, TB, and pneumoconiosis among a large number of miners and former miners in Southern Africa, requiring immediate attention and control in all member states [1].

Pneumoconiosis remains a critical global health threat due to persistent inhalation of mineral dust in mining areas [6]. The global prevalence of pneumoconiosis currently stands at 527,500 documented cases, and 21,000 annual deaths [7]. In Tanzania, no comprehensive studies have been conducted to determine the prevalence of pneumoconiosis among miners due to an inadequate reporting system and diagnostic challenges in local facilities. Some studies have evaluated forms of pneumoconiosis, such as silicosis, as separate entities. Osewe et al. estimated the prevalence of silicosis among informal miners in Northern Tanzania at 1.6%, along with 1.9% for obstructive lung disease and 8.8% for restrictive lung disease [8]. Among miners and community members in Merelani, 11.4% had impaired lung function, and 30% of miners had silicosis [9]. Dennis et al found that among respiratory hospital admissions in Kilimanjaro Christian Medical Centre, 14.3% were diagnosed with silicosis with a positive history of working in mining [10]. However, most of these reports focus on the burden of silicosis among large-scale miners rather than informal miners.

Pneumoconiosis is an umbrella term for multiple occupational interstitial lung disorders that result in lung dysfunction and occur from inhaling mineral dust. The most prevalent types of pneumoconiosis are asbestosis, silicosis, and coal miners' lung [6]. Up to 29.1% of common silicosis cases among informal miners result from even a short time of intense silica dust exposure [1], [11]. The main clinical manifestations of pneumoconiosis are pulmonary inflammation and fibrosis, and the primary diagnostic techniques are chest radiography and a history of exposure to hazardous dusts. Pneumoconiosis results in lung damage, and unfortunately, there is no presently effective treatment, with care being focused on symptom alleviation and rehabilitation [7].

Like many informal mining projects in the country, the Katavi region hosts numerous artisanal miners engaged in gold, green tourmaline, gemstone, and copper mining. These mining activities began back in 1990 and serve as the backbone of the region's economy. However, health and safety practices fall below international labour standards, and workers are continually exposed to mining dust.

Despite increasing recognition of occupational respiratory diseases among miners, reports describing advanced pneumoconiosis among Tanzanian artisanal miners remain scarce. Furthermore, unusual complications and diagnostic challenges in tuberculosis-endemic areas are poorly documented. We report two fatal cases of complicated pneumoconiosis to highlight the important diagnostic pitfalls, rare clinical manifestations, and implications for occupational health surveillance and clinical practice.

Case presentation

Case 1

A 34-year-old African male with a 4-year occupational history of underground mining (drilling) presented with progressively worsening dyspnoea and chronic cough over 1 year. He was transferred to our hospital for worsening respiratory symptoms. Two weeks before admission, his respiratory symptoms markedly worsened on exertion. They were associated with chest tightness, left-chest discomfort when lying down flat, intermittent fever, and significant weight loss over six months. He had no history of smoking but drank alcohol occasionally. He was initiated on anti-tuberculosis (TB) treatment based on chest radiographic findings despite the absence of microbiological confirmation.

On examination, the patient was alert but severely hypoxemic with an oxygen saturation of 70% on room air, improving to 92% with 15L/min oxygen via a non-rebreather mask. He was tachycardic (110bpm) with a respiratory rate of 25 breaths per minute, and blood pressure of 105/72mm Hg. Cardiovascular examination revealed distended jugular veins and an apex beat located at the fifth intercostal space in the left midclavicular line, with normal heart sounds and no murmurs, heaves, or thrills. Respiratory examination showed tracheal deviation to the right, reduced chest movement, decreased breath sounds, and vocal fremitus over the left hemithorax. The right hemithorax exhibited a dull percussion note and distant breath sounds. Laboratory investigations showed a negative GeneXpert MTB/RIF assay, mildly elevated erythrocyte sedimentation rate (ESR) of 16 mm/hour, leucocytosis with neutrophilia (9.841×109/L), lymphopenia (0.4394×109/L), and microcytic hypochromic red blood cells. Serology tests for HIV confirmed a negative HIV status, and SARS-CoV-2 was negative. Chest CT scan illustrated in Fig. 1**(A and B)** showed extensive right lung parenchymal consolidation with air bronchograms and associated fibrotic changes, and a focal bleb at the lateral basal segment of the right lower lobe. Also, a consolidative lung collapse is seen involving the left lung, suggestive of progressive massive fibrosis (PMF) with localized emphysematous change (bleb formation), consistent with complicated silicosis. Laryngoscopy showed a shortened epiglottic tip with scarring, but normal vocal cord mobility and an absence of lesions or foreign bodies. These findings collectively suggested severe pulmonary compromise without cardiac involvement.

This patient presented with progressive difficulty breathing, coughing for over a year, significant weight loss, and a history of ongoing treatment for TB. The differential diagnoses included pneumoconiosis, post-TB lung disease sequelae, and active TB. Given the patient's 4-year history of mining and the chronic nature of his respiratory symptoms, pneumoconiosis was a primary consideration. The chest CT findings of consolidation and fibrotic bands in the right lung were consistent with silicosis. Also, the presence of spontaneous pneumothorax is likely due to ruptured subpleural blebs, which is a known complication of silicosis.

The absence of a recent TB infection and the patient's occupational exposure further supported this diagnosis. Chronic silicosis was confirmed based on the CT findings and the patient's prolonged exposure to mining dust. The patient had a history of TB, treated 1 month earlier, raising the possibility of post-TB lung disease. This condition can lead to chronic respiratory symptoms due to residual lung damage. However, the GeneXpert sputum analysis was negative, with no clinical signs of active TB. The CT findings

were more consistent with silicosis rather than post-TB sequelae. The patient's symptoms and history of TB warranted consideration of reactivation or a new TB infection. However, the negative GeneXpert test and the lack of new TB contacts reduced the likelihood of this diagnosis. The elevated ESR indicates inflammation, but not specifically TB, which could be due to emphysema secondary to complicated silicosis.

The patient received oxygen therapy at 15 L/min via a non-rebreather face mask to manage his symptoms. Initially, he was administered dexamethasone (8 mg intravenously 8-hourly daily for 7 days, which was later changed to prednisolone 20 mg orally once daily. He was also prescribed montelukast (10 mg once daily), salbutamol nebulization 6 hourly for the entire duration of his admission in the ward. In addition, he was given intravenously amoxiclav 1.2gm twice a day for 7/7, while in the ward, and underwent chest physiotherapy. Within 7 days of hospital stay, he reported some minimal symptomatic improvement; however, he could not maintain adequate oxygenation without supplemental oxygen for most of his stay. The patient remained admitted in the ward for 2 months; during that time, he awaited the provision of a portable oxygen concentrator. While in the ward, his condition unexpectedly deteriorated, leading to his death. The immediate cause of death was respiratory failure due to chronic silicosis.

Case 2

A 30-year-old male, formerly an artisanal miner with 11 years of occupational silica dust exposure, presented with progressive dyspnoea, chest tightness, non-productive cough, and exertional shortness of breath that had gradually worsened over one year, with marked deterioration during the two weeks before admission. He had left mining 3 years earlier to engage in farming. He also reported significant weight loss and intermittent low-grade fever but denied night sweats, haemoptysis, smoking, chronic medical illnesses, or known tuberculosis (TB) contact.

On examination, the patient appeared cachectic and severely hypoxemic with an oxygen saturation of 62% on room air, improving to 94% on 15L/min oxygen via a non-rebreather mask, with a respiratory rate of 23 breaths per minute. Respiratory examination demonstrated reduced bilateral chest expansion, binasal dullness, fine inspiratory crackles, and diminished breath sounds. Cardiovascular examination revealed irregular pulse rate, jugular venous distention, lower limb pitting oedema, and a diastolic murmur.

Laboratory investigations showed leucocytosis, predominantly of neutrophilia, while renal and liver function tests, HIV serology, and GeneXpert for Mycobacterium tuberculosis were all negative. Echocardiogram revealed a thickened and calcified pericardium with preserved left ventricular systolic function. Chest CT revealed extensive bilateral upper lobe fibrosis with cystic changes, traction bronchiectasis, and architectural distortion, classic for progressive massive fibrosis (PMF) **(**Fig. 2.1**)**. Additional CT findings included bilateral basal fibrotic bands and curvilinear pericardial calcifications, supporting constrictive pericarditis, suggestive of constrictive pericarditis associated with silica-related diseases (Fig. 2.2**)**.

The initial differential diagnoses included pneumoconiosis, active TB infection, bacterial pneumonia, and post-TB lung diseases. Although TB was initially suspected because of chronic respiratory symptoms and

weight loss, negative GeneXpert results, absence of TB exposure, and characteristic radiological findings made active TB unlikely. A prior bacterial pneumonia and pericarditis were considered as differential diagnoses to this case, given that CBC showed leucocytosis and neutrophilia. The patient's occupational history as an artisanal miner for 11 years, combined with his significant exposure to dust, and clinical symptoms strongly suggested complicated silicosis with superimposed infection. Also, the chronicity of his symptoms, coupled with radiological evidence of progressive massive fibrosis (PMF) and calcifications of the pericardium, confirmed the diagnosis of pneumoconiosis complicated by constrictive pericarditis and superimposed infections.

The patient received high-flow oxygen therapy at 15 L/min via a non-rebreathing face mask, bronchodilators (salbutamol nebulization and montelukast), corticosteroids (intravenous dexamethasone followed by oral prednisolone), sildenafil, and broad-spectrum antibiotics (intravenously administered amoxicillin-clavulanic acid followed by oral azithromycin). Despite one month of hospitalization, he remained oxygen -dependant with minimal clinical improvement. His condition subsequently deteriorated, and he died from respiratory failure secondary to advanced pulmonary fibrosis caused by pneumoconiosis.

Discussion

Pneumoconiosis is a health challenge among miners and peri-mining communities, resulting from occupational exposure to respirable dusts. Informal miners constantly work in congested underground mines and are exposed to numerous occupational health and safety hazards [12]. Logically, it would be expected that the burden of respiratory complications increases with an increase in working duration; however, this case report revealed that duration of exposure is only one determinant of the disease risk. The intensity and cumulative dose of respirable crystalline silica are often more important in posing a risk of severe respiratory complications. This unexpected finding has been reported by Mbuya et al., who observed that miners with over ten years of employment and those with 6 years of employment had 66% and 48% lower odds of silicosis, respectively, compared to miners with five years or less of employment [8]. In many mining sites, it's well known that artisanal miners and small-scale mining workers often perform drilling, crushing, and grinding in poorly ventilated environments with minimal dust control and inadequate use of PPE [13], [14], [15]. Continued progression of silicosis may also occur after exposure has ceased because the inflammatory and fibrotic processes initiated by retained silica particles persist within the lungs. Failure to regular medical check-up, late diagnosis, and inadequate treatment may significantly lead to disease complications, poor prognosis, high cost of treatment, and premature death [16].

In different circumstances, pneumoconiosis is frequently misdiagnosed as TB [23], as revealed in the current case report. This is a common experience in mining communities; however, silicosis significantly increases the risk of tuberculosis, particularly in the context of Human Immunodeficiency Virus (HIV)[24]. In 2023, the TB prevalence among mining communities in Tanzania was 7%, about 24 times higher than the national prevalence of 0.295% [25]. Despite the alarming TB burden in the country, miners believe that they have recurrent TB because the symptoms of tuberculosis (TB) and silicosis are similar. Given that pneumoconiosis is incurable, patients' symptoms persist even after TB therapy is finished, as revealed in the presented cases. Literature revealed that the vicious cycle of pneumoconiosis progression starts when

ASM with previous exposure to occupational hazards get symptomatic relief; they return to dusty work settings, increasing their exposure to silica dust even more [26]. The nomadic nature of ASM lives from one mining pit to another, task shifting, extreme poverty, and poor health-seeking behaviours expose ASM to both pneumoconiosis and tuberculosis, which gradually develop into advanced respiratory disease [25].

Additionally, in many primary health care facilities in mining areas, the majority of patients with pneumoconiosis have been inappropriately treated for TB based on symptoms and misinterpreted chest X-rays without microbiological or Gene Xpert confirmation, as presented in this case report. Previous literature reports that health resource scarcity in terms of diagnostic tools, treatment options, and trained healthcare professionals, like pulmonologists and physicians, is the major challenge in mining communities [20]. This underscores the urgent need for improved health measures in occupational activities. At the basic level, health care practitioners should take a detailed occupational history in all patients presenting with lung disease symptoms, and pneumoconiosis should be considered in all former miners with abnormal Chest X-Rays. Additionally, this case report highlights the need for compliance with TB algorithms, including considering other diagnoses for Expert-negative cases before commencing empirical treatment.

However, the diagnosis of pneumoconiosis and other respiratory conditions is more accurate when diagnostic tools, like computerized tomography (CT) and trained health professionals, are easily available in the health facility [21]. The unavailability of additional investigative tests, such as spirometry, Mantoux tuberculin skin test, and fungal infection culture, in both cases prevented the establishment of a more definitive differential diagnosis.

Pulmonary diseases associated with mining can either progress over time or have long-term effects that bear a serious impact on former miners' lives years after they leave the mining activities, as shown in the studied patients in this case report. According to Tanzania’s laws, rules, and regulations, occupational health and safety precautions are formulated and implemented by different ministries under the Occupational Health and Safety (OSH) Act of 2003 and the Workers’ Compensation Act of 2008 [17]. This act mandates employers to mitigate workplace hazards by providing personal protective equipment (PPE) and safety training to employees. Conversely, the latter facilitates compensation for employees afflicted by work-related injuries or illnesses without the obligation to establish employer culpability. While the OSH Act espouses non-discrimination, its practical application poses challenges for informal miners with financial incapacitation, leaving only formal miners protected by this law [18]. Formal mining employers mostly conduct regular risk assessments, establish respective health and safety systems in line with national laws and regulations, and supply their workforce with adequate personal protective equipment (PPE) [19]. Regrettably, artisanal miners encounter barriers in accessing these benefits due to the limited availability of OHS near mining areas, financial access barriers, and the low degree of risk awareness [12]. The persistence of informality in accessing occupational health and safety among miners needs to be dismantled as a rational strategy for those who profit from it. It is also necessary to reorient traditional OHS mechanisms to utilise worker-led approaches, which are simpler, less expensive, and more suitable.

Furthermore, in both cases we addressed, the extension of the patient's hospital stays was due to an advanced state of pneumoconiosis, which required rehabilitation care, including oxygen therapy, lifestyle modifications, respiratory training, and psychological counselling, along with financial constraints for paying hospital bills. This emphasizes early disease screening and management, preventing disease progression to severe forms, reducing hospital admissions, and shortening hospital stays [22]. The establishment of an integrated approach that engages health care systems, miners, community members, and compensation fund bodies is crucial to ensure that artisanal miners are protected from the risks associated with occupational hazards and receive compensation fund during treatment and rehabilitation care.

Key Clinical Learning Points

- Consider pneumoconiosis in miners with chronic respiratory symptoms, particularly when tuberculosis investigations are negative
- A detailed occupational history and chest CT are essential for early and accurate diagnosis
- Silica exposure may rarely involve extrapulmonary organs, including constrictive pericarditis, requiring multidisciplinary assessment.
- As pneumoconiosis is irreversible and may progress even after exposure ends, prevention through dust control, regular screening and appropriate use of personal protective equipment remains the most effective strategy.

Study Limitation

The report has several limitations. Histopathological confirmation and pulmonary function testing were unavailable because of limited diagnostic resources. Quantitative occupational exposure assessment was not performed, and environmental silica measurements were unavailable. Nevertheless, the combination of detailed occupational history, characteristic chest CT findings, exclusion of active tuberculosis, and multidisciplinary clinical assessment strongly supported the diagnosis of complicated pneumoconiosis.

Conclusion and recommendation

These cases emphasize that pneumoconiosis should be considered in miners presenting with chronic respiratory symptoms, particularly when tuberculosis investigations are negative, or patients fail to respond to empirical anti-tuberculosis therapy. Early occupational history taking, timely chest X-ray and CT imaging, regular health surveillance, effective dust-control strategies and improved access to occupational health services are essential to prevent advanced disease and reduce preventable mortality among artisanal miners

Patients’ perspective

Patient 2: “My condition is worsening; my life is going to end, such that without an oxygen machine, I can't live. Though I am okay except for breathing without oxygen, no one had ever told me that I could come to this poor health condition. I wish I had known this earlier. I feel sorry for those who keep on drilling, like me. As I was at work, I was healthier. I came to experience this condition after I stopped mining and went into farming.”

Declarations

Authors' contributions

CC contributed to the conception, design, clinical data collection, and drafting of the manuscript. NM, AT, LM, and LM contributed to the analysis and interpretation of the data. HD, EB, JM, KS, HG, FE, and DB contributed to the final editing of the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors sincerely thank all colleagues of the departments of Internal Medicine, Laboratory, and Radiology in Katavi Referral Regional Hospital, Tanzania.

Ethical approval and consent to participate

Ethical approval for publication of this case report was granted by Katavi Regional Referral Hospital Research and Ethics Committee (Approval No. KTV/RRH/H.10/61/11). Written informed consent for publication of the clinical information and accompanying images was obtained from the patients or their legally authorized representatives.

Consent for publication

Written informed consent was obtained from the patients for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Consent to participate

All participants voluntarily consented and agreed to participate in this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Availability of data and materials

No data sets were analysed during the current study

Competing interests

The authors declare no competing interests.

Disclaimer

The Katavi Regional Referral Hospital, as well as all stakeholders who implemented occupational safety monitoring Evaluation, had no role in the writing of the article. The findings and conclusions contained within are those of the authors and do not necessarily reflect the position or policies of the hospital and other stakeholders.

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Figures

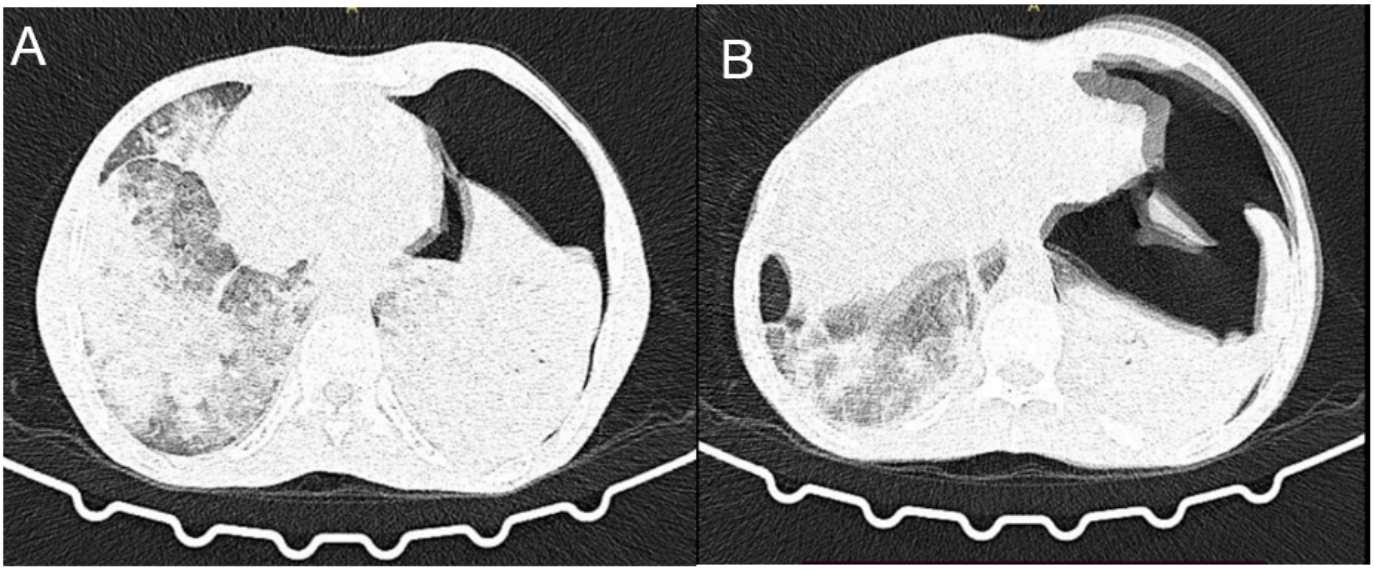


Figure 1

(A and B): *Axial non-contrast CT chest images showing extensive right lung parenchymal consolidation with air bronchograms and associated fibrotic changes, predominantly involving the right upper lobe. A focal bleb is noted within the lateral basal segment of the right lower lobe. Consolidative lung collapse is seen involving the left lung. Imaging features are suggestive of progressive massive fibrosis (PMF) with localized emphysematous change (bleb formation), consistent with complicated silicosis.*



Figure 2

Figure 2.1 (A) Axial and (B) *coronal NCCT chest images showing predominantly upper lobes bilateral diffuse lung fibrosis with cystic changes of variable sizes, bilateral ground-glass opacities, traction bronchiectasis changes, and architectural distortion, classic for progressive massive fibrosis (PMF).*

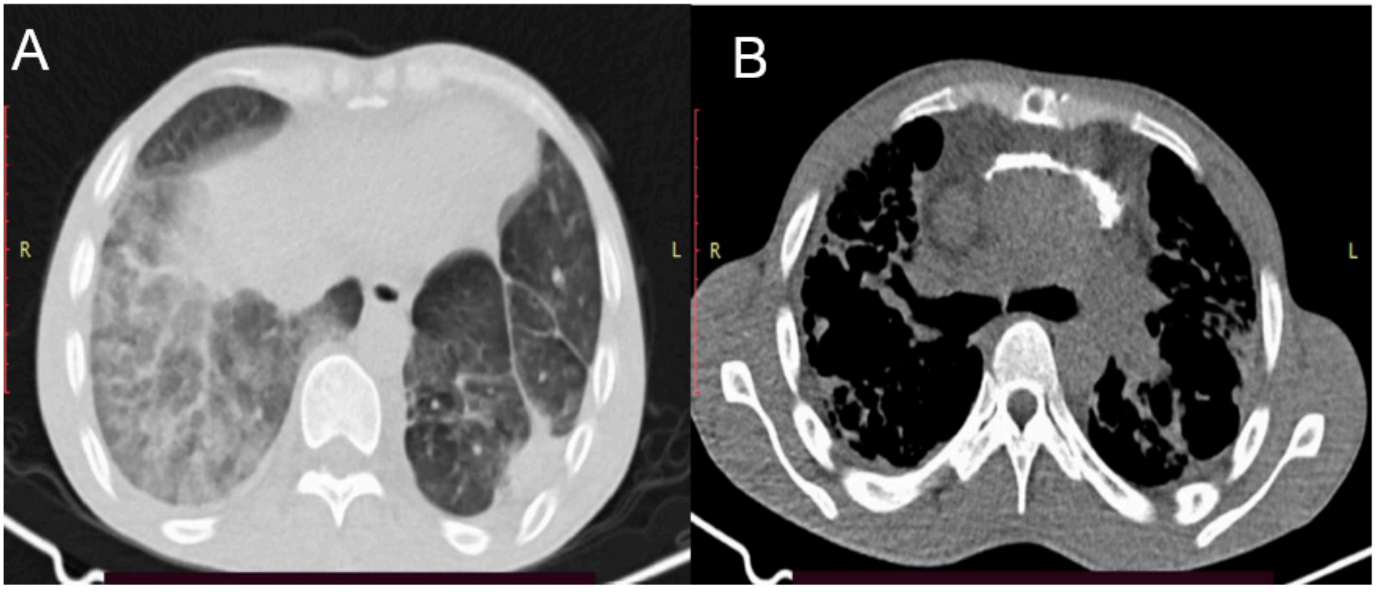


Figure 3

Figure 2.2 (A and B): *Axial NCCT chest images showing Bilateral lung bases ground-glass appearance with diffuse fibrotic bands and curvilinear calcifications at the pericardium, suggestive of prior pericarditis as TB sequelae/constrictive pericarditis, which is a common complication in silicosis.*