Silicosis: A pictorial review.

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Learning objectives

To illustrate radiological findings of silicosis involving hilar and mediastinal lymph nodes and lung parenchyma on chest radiographs, conventional CT and High Resolution CT (HRCT).

To emphasize diagnostic features enabling differentiation from other multinodular diseases and conglomerate masses.

Background

Silica dust as a potential health problem is known since 19th century.

Silicosis is an irreversible occupational lung disease caused by chronic inhalation of dust containing crystalline silica. Normally, in classic silicosis, it is necessary 15-20 years of exposure to silica dust to develop clinical manifestation and radiological findings.

Our population has a significant number of marble masons working as stoncutters, polishers or glass, pottery and porcelain manufacturer. Other occupations affected by silicosis are brick lining, mining, quarrying, tunneling or sandblasting. This fact can justify the high prevalence of silicosis in this geographical area. Every patient reported of silicosis in our hospital were men under 40 years old who had been working with marble at least for 8 years.

A multidisciplinary follow-up is necessary for these workers.

Imaging findings OR Procedure details

It is compulsory to know that there are two very different clinical forms depending on the characteristic of silica dust exposure; classic silicosis and acute silicosis.

1. CLASSIC SILICOSIS:
a. SIMPLE SILICOSIS:

- **PARENCHYMAL ABNORMALITIES:**

Chest radiography is helpful for initial silicosis diagnosis in marble masons. Conventional CT is more sensitive in depicting silicosis and it can help identifying illness in its early stages. HRCT is helpful in distinguishing silicosis from other causes of parenchyma abnormalities.

**Micronodular pattern:**

Silicosis is characterized by a micronodular pattern, with well defined and uniform nodules in shape and range from 1 to 10 mm in diameter (usually between 2-5 mm). These nodules are predominantly located in the upper lobe and posterior portion of the lung (Fig 1, 2). In advanced disease, a diffuse distribution with affection of the whole lung is probable (Fig 3).

HRCT allows a more accurate localization of micronodules, facilitating a differential diagnosis.

Nodules, in silicosis, are usually located in centrilobular, paraseptal and subpleural regions and have a perilymphatic distribution (Fig 4, 5).

In a majority of patients with multinodular disease, it is possible to provide a specific diagnosis or a shortened list of differential diagnosis with a systematic reading of HRCT features.

Depending on the predominant location of the nodules, we can orientate into different possibilities (Fig 6):

Diffuse pulmonary nodules localized in the fissure or pleural surfaces of the upper lobe with a distribution in the perihilar area or randomly, as well as, clustered suggest silicosis or coal workers` pneumoconiosis, whereas lower lobe preponderance is more likely in asbestosis or hematogenous metastases. Bronchocentric predominance suggests sarcoidosis.

Nodules calcify in about 3% of cases. Subpleural nodules manifest with rounded or triangular shapes, and if they are confluent, they might resemble pleural plaques. In
this form, chains of subpleural nodules produce pseudoplaques, which might present calcifications inside as well (Fig 7).

- **PLEURAL DISEASE:**

Pleural thickening and calcification:

Pleural thickening is one of the common findings in silicosis (Fig 8). Both, the visceral and parietal pleura are thickened in most patients affected. The extent of pleural thickening is more frequently seen in complicated silicosis and it is wider in complicated cases than in simple ones. There is no difference in incidence of pleural thickening between patients with and those without history of tuberculosis. Pleural calcification is always limited spaciously and is seen in 10 % of patients.

Pleural effusion:

In the literature, there are not many case reports that described the association of pleural effusion and silicosis, saying that in about 10 % of the cases, pleural effusion does not have identifiable association other than pneumoconiosis. Bilateral pleural effusion is more frequent and the presence of pleural effusion is as frequent in complicated as in simple silicosis.

Pleural fibrosis:

It occurs as a result of scarring and fibrosis in the pulmonary parenchyma. It is less frequently identified in early silicosis.

- **LYMPHADENOPATHY:**

Hilar and mediastinal lymph node enlargement is a frequent finding that may precede the visualization of parenchymal nodular lesions (Fig 9, 10).

Calcification of lymph nodes is common and typically occurs at the periphery of the node, obtaining the called "eggshell" calcification pattern which is highly suggestive of silicosis (Fig 9, 11).

**b. COMPLICATED CHRONIC SILICOSIS:**

- **PROGRESSIVE MASSIVE FIBROSIS:**
In a final stage, progressive massive fibrosis (PMF) is seen, especially in subpleural location, indicating the presence of complicated disease. PMF develops by means of conglomeration of nodules lesions, and the intervening tissue collapses with interstitial fibrosis, leading to the formations of a solid mass of fibrosis.

Typical pattern shows masses larger than 1 cm, bilateral and symmetrical, in the upper lobes, which may present internal calcifications. These conglomerates tend to migrate towards the hilum, showing areas of emphysema between fibrous tissue and the pleura. PMF is always associated with a background of small nodules visible on CT (Fig 12-15).

• **SILICOTUBERCULOSIS:**

Pulmonary tuberculosis might complicate silicosis in a quarter of patients with this disease. CT features include nodules or consolidations with asymmetrical distribution, being cavitation the strongest indicator of silicotuberculosis (Fig 16).

• **BRONCHOGENIC CARCINOMA:**

The association of silicosis with bronchogenic carcinoma is well known since 1996 when silica was classified as occupational carcinogen by the IARC (American Agency for Research on Cancer).

Lung carcinoma might be hidden on chest radiographs in early stages by concomitant lung disease. Serial examination or biopsy will be necessary.

The illustrative features that suggest carcinoma are an unilateral mass with a fast growth in posterior controls that might cavitate and rarely shows calcifications inside (Fig 17).

2. **ACUTE SILICOSIS:**

Acute silicosis is a consequence of a short period of exposure to a large amount of silica dust. Ground-glass opacities (Fig 18), bilateral consolidation or crazy-paving pattern in perihilar regions are typical radiological findings, considered as a result of the filling of the airspace in the lung with proteinaceous material.

Crazy-paving pattern is a common pathological feature related to sandblasting, unseen in our hospital.
Fig. 1: Multinodular pattern in a 26-year-old man. (a, b) Chest radiograph shows well-defined multiple nodules, predominantly in upper and middle lobes and posterior portion of the lung. (c) Axial section of Conventional CT obtained at the level of the heart shows bilateral and posterior region preference multinodular pattern. (d) High resolution CT image depicts subpleural and centrilobular location of nodules.
**Fig. 2:** 27-year-old man who worked as a porcelain manufacturer for 8 years. Maximum intensity projection (MIP) on axial (a), coronal (b) and sagittal (c) images show well-defined micronodules predominantly located in the upper lobe and posterior portion of the lung.
**Fig. 3:** Evolution of multinodular pattern on chest radiographs from nodules with predominance in upper lobe (a, b) to diffuse multinodular disease (c, d).
Fig. 4: Axial at different levels High Resolution CT images of a 28 year-old man show typical distribution of micronodules in silicosis (a-d).
Fig. 5: Diagrammatic representation of secondary lobular anatomy (words in black) and the characteristic distribution of lung nodules in patients with perilymphatic disease, such as silicosis (words in colour).
**Fig. 6:** Orientative algorithm for differential diagnosis of multinodular pulmonary pattern. Representative distribution of micronodules in silicosis (image in the box).
Fig. 7: (a) Subpleural nodules with rounded and triangular shape on HRCT. Confluence of subpleural nodules, resembling pleural plaques on HRCT (b, c) and Conventional CT (d, e).
**Fig. 8:** Pleural thickening on axial Conventional CT image of a patient diagnosed of simple silicosis.
Fig. 9: (a, b) Chest radiographs with micronodular pattern and right hilum enlargement. (c) Chest radiograph shows egg-shell calcifications in both hila with a conglomeration of small nodules in the background.
Fig. 10: Lymph node enlargement in a 35-year-old man who works as a stonecutter. (a) Scout view of Conventional CT shows a diffuse pattern of pulmonary nodules with hilar enlargement associated. (b, c, d, e, g) Axial Conventional CT images with mediastinal window show multiple mediastinal and hilar lymph nodes, most of them with no calcifications inside. (f, h) Axial images with parenchymal window show hilar lymph node enlargement and micronodular pattern.
Fig. 11: (a-d) Axial Conventional CT images with calcified hilar and mediastinal lymph nodes in its different forms; peripheral and egg-shell calcifications (a, b) and fully calcified nodes (b, c, d).
Fig. 12: HRCT and Conventional CT of a 31-year-old man with complicated silicosis. (a) Axial HRCT image represents a conglomerate mass in the right upper lobe. (b) Axial (c, d), coronal and (e) sagittal Conventional CT images show bilateral and symmetrical conglomerate masses, located in upper lobes. A characteristic background of small nodules is associated.
Fig. 13: (a, b) Axial images with parenchymal and mediastinal windows showing paracicatrical emphysema (arrow) associated to apical lobe conglomerate masses.
**Fig. 14:** (a) Posteroanterior and (b) lateral chest radiographs in a 31-year-old man with silicosis. Bilateral condensations in upper and middle lobe are seen with a parenchymal multinodular pattern in the background.
Fig. 15: (a-e) Axial Conventional CT images of the same patient as in Figure 14. Accentuate multinodular pattern with bilateral pulmonary condensations are seen.
Fig. 16: Axial Conventional CT images with parenchymal window, obtained at the level of the aortic arch (a), pulmonary arteries bifurcation (b) and the heart (c) demonstrate bilateral conglomerate masses closed to the hilum. There are at least two cavitations within the conglomerate mass located in the left lung, consequence of silicotuberculosis.
Fig. 17: Axial Conventional CT image with mediastinal window shows a right hilar mass. This finding corresponds to a bronchogenic carcinoma in a patient exposed to inorganic powder.
Fig. 18: 29-year-old man with acute on chronic silicosis. Axial Conventional TC (a, c, e, g) and HRCT (b, d, f, h) images at different levels show ground-glass opacities in bilateral and perihilar location with multinodular pattern in the background.
Conclusion

Radiologic follow-up in marble masons should be done by chest radiographs.

The findings of pathological features make conventional CT and HRCT necessary to distinguish silicosis from other multinodular diseases and conglomerate masses.

Typical imaging features of silicosis are provided to make differential diagnosis easier.

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References
