



## CASE REPORT

# Silicosis in dental supply factory workers

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### KEYWORDS

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**Summary** Dental products contain a variety of potentially hazardous materials, including metals, organic chemical compounds, plastics, and inorganic mineral dusts. The risk of silicosis has been documented for workers of dental laboratories, but not dental supply factories, where the exposures could be expected to be higher. We report in this article five cases of silicosis, four of them with progressive massive fibrosis, in workers from two dental supply factories. This report underlines the need for effective occupational health programs in this type of industrial facilities.  
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## Introduction

Development of silicosis has been associated with a wide variety of industrial activities and occupations,<sup>1,2</sup> the disease is considered the most common form of pneumoconiosis, and its incidence may be increasing in some developing countries.<sup>3</sup> In industrialized countries, on the other hand, although there is insufficient data on incidence, there has been a steady decline in silicosis mortality.<sup>4</sup> Silica exposures that exceed permissible levels still occur in many industries in the United States<sup>4</sup> and there is evidence suggesting that cases of silicosis can be expected at exposures below those permissible levels.<sup>5</sup> Furthermore, descrip-

tions of new occupational settings for silicosis continue to appear in the medical literature.<sup>6</sup> In this report, we describe five cases of silicosis occurring in two dental supply factories, located in the states of Michigan and New York, respectively. To our knowledge, there are no previous descriptions of silicosis in workers from this type of industrial facility.

## Case reports

Table 1 summarizes the clinical, laboratory data, and occupational data on the five cases. The patients (all male) were symptomatic with varying degrees of exertional dyspnea and cough. Wheezing was a salient feature in three of them (cases No. 1, 3, and 5). The chest radiographs showed the typical appearance of silicosis, with rounded opacities predominantly in the upper lung zones. In four of

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**Table 1** Clinical data summary for the cases of silicosis in dental supply factory workers.

Case No.	1	2	3	4	5
Age at diagnosis	49 years	37 years	55 years	61 years	52 years
Age of silica exposure	22–49 years	18–37 years	38–55 years	26–61 years	25–32 years
Tobacco use	None	None	Ex-smoker for 4 years (40 pack-years)	Ex-smoker for 33 years (7 pack-years)	None
Job title(s)	Formulator, chemical processor, material handler	Chemical processor	Chemical processor, refractory leader, general supervisor	Packager, grinder, chipper, truck driver	Mixer
Chest X-ray (ILO B reading) <sup>13</sup>	Upper lobe opacification diffuse opacities (0/0)	Small and large rounded opacities (r/r 1/1 large opacities A)	Severe PMF (q/q 1/0 large opacities, B)	Small rounded opacities in upper lobes (q/r 1/1)	Severe PMF (p/p 1/1 large opacities A)
Spirometry	Mild obstruction	Restriction	Severe obstruction, low FVC	Normal	Severe obstruction
Lung volumes	Normal	Moderate restriction	ua	ua	Mild restriction
Diffusion	Normal	ua	ua	ua	Moderately reduced
Co-morbidities	None	Rheumatoid arthritis	COPD	—	Asthma
Follow-up	4 year, alive	5 year, dead	13 year, dead	1 year, alive	2 year, alive

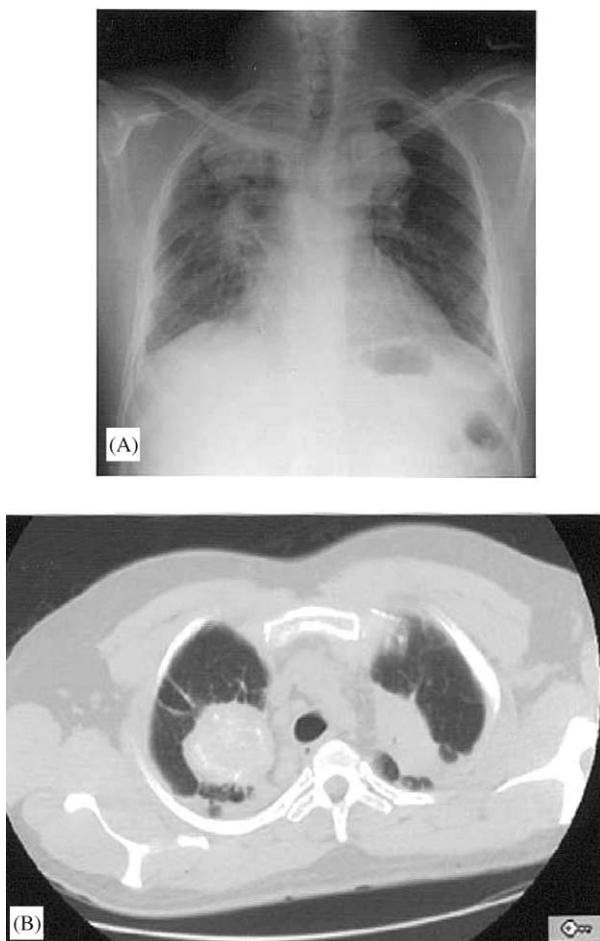
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the cases the radiographic features were those of complicated silicosis (i.e., nodules larger than 1 cm in diameter). Three of the cases (No. 1, 3, and 5) had more severe progressive massive fibrosis (PMF), with large conglomerate masses with diameters exceeding 3 cm in the upper lung zones, emphysema-like changes in lower lobes, with or without mediastinal and/or hilar adenopathies (Fig. 1A and B). Additional functional data included documentation of hypoxemia at rest for case No. 1 ( $PaO_2 = 68$  mmHg) and on exercise for case No. 5 ( $PaO_2 = 63$  mmHg), who also had a decreased exercise capacity ( $VO_2\max = 16.7$  ml/min/kg, 52% of predicted).

Histopathologic confirmation of the diagnosis was achieved in two of the cases (by open lung biopsy in No. 1, and by transthoracic large bore needle biopsy in No. 5). Transbronchial biopsy samples from cases No. 2, 3, and 5 were adequate to exclude alternative diagnoses such as sarcoidosis, infection, or malignancy. Delays in diagnosing silicosis were considerable (e.g., 2 years for case No. 5). None of the patients had active tuberculosis at diagnosis or during follow-up, but two of them

(cases No. 3 and 5) had positive tuberculin skin tests and received treatment for latent tuberculosis. Case No. 2 had rheumatoid arthritis, but the clinical and radiologic features were not suggestive of Caplan's syndrome.

Four of the cases (No. 1–4) were diagnosed at a facility in the state of Michigan, and the remaining one was diagnosed in New York state. The factories (belonging to Standard Industrial Classification [SIC,<sup>7</sup>] 3843), were dedicated to the production of dental materials, including impression mixes, denture polymer mixes, composite resins, dental abrasives, investment casting powders, and similar products. Large amounts of silica (up to 40,000 lb/day in the Michigan factory) and flux calcined diatomaceous earth (with up to 75% crystalline silica content) were handled at these facilities. A detailed industrial hygiene evaluation at the Michigan factory demonstrated two- to three-fold elevations (compared to the permissible level of  $0.05$  mg/m<sup>3</sup>) in cristobalite levels. Company records had documented previous silica overexposures, and at least three previous cases of "lung disease" or silica-related disease. At that factory,



**Figure 1** Postero-anterior view of a chest radiograph (A), and a high-resolution computerized axial tomography image (B) from case No. 5, with characteristic appearance of partially calcified progressive massive fibrosis, no large adenopathies, and with focal areas of pleural thickening.

the silica powder was conveyed in the ductwork under positive pressure. Small leaks in the system could therefore expel large amounts of powder into the ambient air. Accumulation of powdered silica was observed on the ceiling, walls, rafters, and equipment. There was insufficient enclosure and exhaust ventilation in the formulating station, where silica bags were opened by dropping them onto a "spike". There was no adequate respiratory protection program at the New York factory. In the Michigan factory, such program was adequate at the time of diagnosis of the cases. However, an update enforcing a "no beard with respirator" policy had taken place only 2 years before, suggesting that the program had not fully met accepted safety standards until then.

Detailed occupational exposure history revealed silica exposure durations exceeding 15 years for four of the five cases (Table 1), and there was no

alternate or additional sources of exposure to silica or other fibrogenic dusts for any of the cases. Job titles and duties varied over the years for each of these workers, and included both direct and indirect silica handling and exposure. The latter consisted of crystalline silica (cristobalite and crystalline quartz) for cases No. 1–4, and to flux calcined diatomaceous earth (75% crystalline silica), for case No. 5. Concurrently with the silica exposure, there was also some exposure to kaolin for case No. 5, and exposures (without any evidence of related illness) to lead, mercury, silver, and formaldehyde for the other four cases.

## Discussion and conclusion

Although mortality from silicosis clearly continues to decline in the United States, cases still occur and may be underdiagnosed and/or underreported. Silica is still widely used in this country, and the most recent available estimates indicated that the total number of potentially silica-exposed workers in nonmining industries is more than two times higher than in mining.<sup>8</sup> Furthermore, reports of new exposure settings continue to appear, and exposure levels exceeding regulatory limits continue to occur across all types of industries.<sup>4</sup>

Silica and other mineral dusts are used as fillers in a variety of dental products, including impression mixes, composite resins, and abrasives. Cases of silicosis have been recognized among dental laboratory (SIC 8072) workers,<sup>9–11</sup> and the occupational hazard posed to dental clinic workers has also received attention.<sup>12</sup> To our knowledge, however, there has been no previous description of the disease in dental supply factory workers. This seems somewhat surprising, taking into account that the potential exposures to respirable silica would be expected to be higher in dental supply factories than in dental laboratories or clinics. The two industrial facilities where our cases occurred handled large amounts of silica. In the New York factory, there was no respiratory protection program in place, and workers were completely unaware of both the nature of their exposures as well as of their associated potential health risks. In the Michigan factory, an inspection at the time of the detection of the cases documented the existence of an adequate respiratory protection program, but silica exposure levels were as high as 2–3 times the permissible levels.

In the past, the finding of complicated silicosis cases in defined working populations was associated with that of a much larger number of cases

after systematic surveys were conducted. It was not possible, however, to conduct such surveys at these facilities. Appropriate regulatory and/or public health intervention was pursued in both facilities, and further cases may be prevented.

This report underlines the need for effective occupational health programs in this type of industrial facility. These programs need to include worker education, exposure monitoring and reduction, and adequate respiratory protection. The occurrence of these cases, in addition to the fact that silicosis cases are still expected to occur under permissible exposure levels,<sup>5</sup> should heighten physicians' awareness of this disease, in the hopes of contributing to its prevention and early detection.

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