Artificial stone silicosis: a UK case series

Johanna Feary ,[1,2] Anand Devaraj,[1,3] Matthew Burton,[4] Felix Chua ,[5] Robina K Coker ,[1,6] Arnab Datta,[7] Richard J Hewitt ,[5] Maria Kokosi,[5] Vaslis Kouranos,[5] Carl Jonathan Reynolds,[1,6] Clare L Ross,[6] Veronica Smith,[8] Katie Ward ,[1,6] Melissa Wickremasinghe,[1,6] Joanna Szram[1,2]

[1]National Heart and Lung Institute, Imperial College, London, UK
[2]Department of Occupational Lung Disease, Royal Brompton Hospital, London, UK
[3]Department of Radiology, Royal Brompton Hospital, London, UK
[4]East Suffolk and North Essex NHS Foundation Trust Ipswich Hospital, Ipswich, UK
[5]Interstitial Lung Disease Unit, Department of Respiratory Medicine, Royal Brompton Hospital, London, UK
[6]Department of Respiratory Medicine, Imperial College Healthcare NHS Trust, London, UK
[7]London North West University Healthcare NHS Trust, Harrow, UK
[8]Kingston Hospital NHS Foundation Trust, Kingston upon Thames, UK

Correspondence to
Dr Johanna Feary, Imperial College London National Heart and Lung Institute, London, London, UK;
j.feary@imperial.ac.uk

► http://dx.doi.org/10.1136/thorax-2024-221447
► http://dx.doi.org/10.1136/thorax-2024-221806

To cite: Feary J, Devaraj A, Burton M, *et al*. *Thorax* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/thorax-2024-221715

ABSTRACT

Silicosis due to artificial stone (AS) has emerged over the last decade as an increasing global issue. We report the first eight UK cases. All were men; median age was 34 years (range 27–56) and median stone dust exposure was 12.5 years (range 4–40) but in 4 cases was 4–8 years. One is deceased; two were referred for lung transplant assessment. All cases were dry cutting and polishing AS worktops with inadequate safety measures. Clinical features of silicosis can closely mimic sarcoidosis. UK cases are likely to increase, with urgent action needed to identify cases and enforce regulations.

BACKGROUND

Silicosis is an irreversible interstitial lung disease caused by inhalation of respirable crystalline silica (RCS). Being one of the oldest occupational diseases, globally millions remain at risk of developing silicosis through work in mining, quarrying, stonecutting and construction. Data from 20 years ago estimated that 600 000 people in the UK were exposed to silica and at risk of developing silicosis.[1]

The last two decades have seen rapid growth in use of artificial stone (AS; also called engineered or reconstituted stone or 'quartz') in the manufacture of stone worktops. AS—made from crushed rocks bound together with resins and pigments—offers aesthetic advantages together with the attraction of being easier to work with due to the absence of natural imperfections and more resistant to damage than natural stone. The growing use of AS has seen the emergence of a severe progressive accelerated form of silicosis. This appears to be driven by two specific properties: high (>90%) silica content (contrast marble 3% and granite 30%), and very fine particles generated when cut. Furthermore, after manufacture, AS worktops are prepared for installation and are often 'dry' cut and polished (with an angle grinder or other hand tools), without water suppression of dust, significantly increasing airborne RCS generation.[2]

Since 2010, case series of AS silicosis have been reported from Israel, Spain, Italy, the USA, China, Australia[3] and Belgium.[4] AS has been used in the UK for a similar duration of time[5] but no cases had been reported in the UK until mid-2023, when several were referred to a single specialist occupational lung disease clinic and which are described here.

METHODS

Occupational histories and clinical–radiological–pathological features of cases of AS silicosis referred to a UK specialist centre were reviewed at a multidisciplinary meeting over 8 months. A descriptive analysis was undertaken.

RESULTS

Silicosis attributed to AS was identified in 8 men with median age 34 years (range 27–56) at time of diagnosis, 75% were born outside the UK and 88% were current or previous smokers (table 1). All initially presented with respiratory symptoms but, for some, this was attributed to causes—including sarcoidosis—other than silicosis (based on limited extent of disease and other comorbidities). Median exposure to stone dust was 12.5 years (range 4–40); however, 4 men had only had stone dust exposure for 4–8 years and estimated that 50%–100% of the materials they had used were AS with, in some, additional exposure to granite, marble and other 'natural' stones. Radiological appearances included silicoproteinosis (figure 1), as well as simple and complicated silicosis (figure 2).

Lymphopenia and elevated serum ACE levels were common features; most had histological evidence of non-caseating granulomata—highlighting the potential for cases to be misdiagnosed as sarcoidosis. Three cases had positive autoantibodies and were referred for assessment of autoimmune disease. Two cases received treatment for non-tuberculous mycobacteria isolated from bronchial washings (table); one with acute silicoproteinosis underwent whole lung lavage (WLL) with initial clinical–radiological improvement but subsequent decline. Lung transplant assessment was undertaken in two cases. Against medical advice, three cases continue to work with AS, and self-report reduced exposure to visible dust after introduction of powered respirators and water suppression. No cases were under RCS health surveillance.

All described working for small companies with fewer than 10 employees. None were involved in worktop manufacture or installation but carried out the 'finishing' process, specifically cutting and polishing the worktops before installation. They all reported that this was done without consistent water suppression, without what they felt was appropriate respiratory protection and that even where workshop ventilation was present, they stated that the system had not been serviced or cleaned regularly. None were aware of airborne dust monitoring in the workplace.

Table 1 Demographics, occupational exposures and clinical features of cases

	Total (n=8 unless stated otherwise)
Median age (range)	34 years (27–56)
Country of birth	
UK	2 (25%)
Outside UK	6 (75%)
Smoking	
Current smoker	4 (50%)
Ex-smoker	3 (38%)
Never smoked	1 (12%)
Median exposure history (range)	
All stone exposure	12.5 years (4–40)
Artificial stone exposure	6 years (4–10)
CT appearances	
Simple silicosis (nodules ≤10 mm diameter)	4 (50%)
Complicated silicosis (nodules >10 mm diameter)	3 (38%)
Acute silicoproteinosis	1 (12%)
FEV1 range (% predicted)	0.95 L (23%) to 3.62 L (99%)
FVC range (% predicted)	1.40 L (28%) to 4.57 L (117%)
TLC range (% predicted) (n=7)	25%–114%
DLCO range (% predicted) (n=6)	41%–129%
Histology* (n=6)	
Non-caseating granulomata	5/6 (83%)
Birefringent crystals under polarised light	3/6 (50%)
Bloods	
Lymphopenia	5/7 (71%)
Elevated serum ACE	4/7 (57%)
Positive ANA†	3/5 (60%)
NTM infection	2 (25%)
Current situation	
Lost to follow-up	1 (12%)
Deceased	1 (12%)
Not working	2 (25%)
Working unexposed to AS	1 (25%)
Working exposed to AS	3 (38%)

*Endobronchial biopsy of mediastinal lymph node taken in six cases.
†Antinuclear antibodies (n=1: positive anti-ro and anti-la antibodies; n=1: positive ANA with coarse speckled pattern (titre 1:640) and positive anti U1RNP and anti RNP70 antibodies; n=1: positive ANA with fine speckled pattern (titre 1:160) with positive anti-ro 52 and anti-SS-A antibodies).
AS, artificial stone; DLCO, diffusing capacity of the lungs for carbon monoxide; FEV1, forced expiratory volume in 1 s; FVC, forced vital capacity; NTM, non-tuberculosis mycobacterium; TLC, total lung capacity.

DISCUSSION

We report eight UK cases of AS silicosis in young men. Most were migrant workers, vulnerable to exploitation in the workplace and health inequalities,[6] with short exposure histories. The cases illustrate the typical serological changes seen in silicosis and known associations with autoimmunity[7] and mycobacterial disease. Our cases are generally younger than those reported in the literature but with exposure histories similar to those described in Australia and California.[8] In Victoria, a voluntary screening programme of stone benchtop workers reported a prevalence of AS silicosis of 28.3% (n=117) with a median age of 42.1 years (IQR: 34.8–49.7) and median duration of exposure of 12 years (range 3–43).[9] However, in a multinational consortium of 169 AS workers with silicosis, the mean age was higher (51.7 (±11.4) years) and mean work tenure longer (19.9 years (±9.8) years).[10]

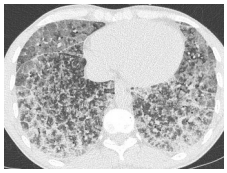

Figure 1 Axial CT section (lung window settings) in patient with acute silicoproteinosis. CT shows a combination of perilobular consolidation, interlobular septal thickening, ground glass opacity and occasional centrilobular nodules.

Figure 2 (A) Axial CT section (soft-tissue windows) showing complicated silicosis with progressive massive fibrosis. There are bilateral perihilar conglomerate masses with punctate calcification. Mediastinal calcified lymph nodes are also demonstrated. (B) Lung window settings at the same level show coexisting nodularity and emphysema.

Onset of disease is likely to relate to exposure levels, suggesting levels, at least for some of the UK cases (and in particular the case of acute silicoproteinosis), were extremely high and implying that employers failed to control dust exposure and to adhere to health and safety regulations. The AS market is dominated by small companies in which regulation has been shown to be challenging to implement.[11] Furthermore, at least some worktop manufacturers may fail to provide adequate technical information relating to potential risks.

Treatment of silicosis is largely supportive and further research including antifibrotic drug trials is urgently needed.[12] Radiological improvement is reported with WLL but data are lacking on optimal timing and long-term outcomes.[13] Even with cessation of exposure, disease progression has been noted in over 50% of cases over a mean of 4 years.[14] Prevention of disease is therefore critical.

Worldwide, an estimated 25 000 people were diagnosed with silicosis in 2017.[15] The global prevalence of AS silicosis is not known (and likely to be underestimated) but has increased exponentially in the last decade.[10] In the UK, the number of AS-exposed workers is unknown but based on global experience, cases of AS silicosis are likely to increase significantly in the coming years.

In 2016, the UK Health and Safety Executive published guidance on health surveillance for RCS exposed workers which includes a chest X-ray after 15 years of exposure. Even if these cases had been in a surveillance programme, based on the latency, this approach will fail to detect at least some cases.

Furthermore, use of chest X-rays in surveillance for AS silicosis is not sensitive.[16] Ideally, any programme would account for intensity, not just duration, of exposure. A concerted effort is required in the UK to prevent the epidemic seen in other countries. The cases we present illustrate the failure of the employer to take responsibility for exposure control in their workplaces. National guidelines are urgently needed, as well as work to enumerate the at-risk population and identify cases early. The introduction of a legal requirement to report cases of AS silicosis, implementation of health and safety regulation with a focus on small companies, and a UK ban on AS (as introduced in Australia in 2024) must be considered.

Correction notice This article has been corrected since it was published Online First. An author's full name was omitted and has now been included.

X Robina K Coker @RobinaCoker1

Collaborators Not applicable.

Contributors JF was responsible for drafting the first version of the manuscript and is the guarantor for the work. All authors contributed to care of the patients, undertook critical appraisal of earlier versions of the manuscript and approved the final version.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

ORCID iDs
Johanna Feary http://orcid.org/0000-0003-2903-6907
Felix Chua http://orcid.org/0000-0001-7845-0173
Robina K Coker http://orcid.org/0000-0002-1875-6717
Richard J Hewitt http://orcid.org/0000-0003-4294-0052
Katie Ward http://orcid.org/0000-0002-8167-4466

REFERENCES

1 Kauppinen T, Toikkanen J, Pedersen D, *et al*. Occupational exposure to Carcinogens in the European Union. *Occup Environ Med* 2000;57:10–8.
2 Mandler WK, Qi C, Qian Y. Hazardous dusts from the fabrication of Countertop: a review. *Arch Environ Occup Health* 2023;78:118–26.
3 Hoy RF, Jeebhay MF, Cavalin C, *et al*. Current global perspectives on Silicosis-convergence of old and newly emergent hazards. *Respirology* 2022;27:387–98.
4 Ronsmans S, Decoster L, Keirsbilck S, *et al*. Artificial stone-associated Silicosis in Belgium. *Occup Environ Med* 2019;76:133–4.
5 Barber CM, Fishwick D, Seed MJ, *et al*. Artificial stone-associated Silicosis in the UK. *Occup Environ Med* 2018;75:541.
6 Moyce SC, Schenker M. Migrant workers and their occupational health and safety. *Annu Rev Public Health* 2018;39:351–65.
7 Fireman EM, Fireman Klein E. Association between Silicosis and autoimmune disease. *Curr Opin Allergy Clin Immunol* 2024;24:45–50.
8 Fazio JC, Gandhi SA, Flattery J, *et al*. Silicosis among immigrant engineered stone (quartz) Countertop fabrication workers in California. *JAMA Intern Med* 2023;183:991–8.
9 Hoy RF, Dimitriadis C, Abramson M, *et al*. Prevalence and risk factors for Silicosis among a large cohort of stone Benchtop industry workers. *Occup Environ Med* 2023;80:439–46.
10 Hua JT, Zell-Baran L, Go LHT, *et al*. Demographic, exposure and clinical characteristics in a multinational Registry of engineered stone workers with Silicosis. *Occup Environ Med* 2022;79:586–93.
11 Department for Business EIS. Challenges businesses face when complying with Regulation;BEIS research paper number. 2020.
12 Li R, Kang H, Chen S. From basic research to clinical practice: considerations for treatment drugs for Silicosis. *IJMS* 2023;24:8333.
13 Chambers DC, Apte SH, Deller D, *et al*. Radiological outcomes of whole lung Lavage for artificial stone-associated Silicosis. *Respirology* 2021;26:501–3.
14 León-Jiménez A, Hidalgo-Molina A, Conde-Sánchez MÁ, *et al*. Artificial stone Silicosis: rapid progression following exposure cessation. *Chest* 2020;158:1060–8.
15 Shi P, Xing X, Xi S, *et al*. Trends in global, regional and national incidence of Pneumoconiosis caused by different Aetiologies: an analysis from the global burden of disease study 2017. *Occup Environ Med* 2020;77:407–14.
16 Hoy RF, Glass DC, Dimitriadis C, *et al*. Identification of early-stage Silicosis through health screening of stone Benchtop industry workers in Victoria, Australia. *Occup Environ Med* 2021;78:296–302.