Silicosis in jade workers

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ABSTRACT The recent finding of cases of silicosis among jade workers in Hong Kong points to this disease being an occupational hazard. The source was found to be the silica flour that was added in a polishing process. Five cases are described together with the results of environmental investigation in a workplace. In three cases the disease was of early onset, rapidly progressive, and presented the features of galloping silicosis noted in other occupational exposures to silica flour. One patient had massive fibrosis and severe glomerulonephropathy, an association that has also been previously noted. One case showed evidence of active tubercular infection in addition to silicosis and two had healed lesions. Silica concentrations in the workplace during the suept process were well above accepted threshold limit values.

The history of jade is enshrined in Chinese legend and folklore. Known as "the stone of heaven" it was attributed mystical properties and was revered as a symbol of power and good fortune. The early carvers were artists of exceptional skill who with infinite patience carved objets d'art from the almost diamond like hard rock. Techniques were speeded up with the advent of metal tools and the Ching dynasty in the eighteenth century saw a widespread increase in jade carving. The art survives today as a relatively small but active industry centred in China and Hong Kong.

The health of jade carvers has not attracted much attention but the recent finding of silicosis connected with the use of silica flour in a polishing process, as reported in this paper, now points to this disease being an occupational hazard. Five cases are described together with the result of workplace investigation.

Material, processes, and premises

The name jade covers nephrite, the original jade stone of ancient times and now rare, jadeite also known as Burmese jade which has been used since the eighteenth century, particularly for jewellery, and bowenite or new jade a mineral of the serpentine group, which being less hard and cheaper than either of the true jades is now the most common.

In addition to the stone itself other materials found

in jade working include waxes and sometimes dyes to improve sheen and colour. Silica flour is used as a polishing agent and creates a special health hazard for the exposed workers.

The main processes are sawing, carving, and polishing. Sawing the parent rock to extract the jade piece with the traditional tool, a steel wire stretched across a bamboo bow, is the first step. Then various drilling techniques using high tension bits achieve the required shape. Finally, the article is polished, usually with the help of a rotating buffing wheel. In the past, drills and polishers were driven by leg pedalling contraptions but more advanced devices are now appearing and electric motors are replacing human muscle as a power source for the tools.

Although production line methods are emerging in some of the larger establishments, jade working still clings to its early cottage industry pattern with small and relatively primitive workshops being the general rule. The workplace is often the home of the craftsman and his family with all the associated possibilities of prolonged exposure to dust or other occupational hazards.

Case detection

Silicosis is a common occupational disease in Hong Kong with a high prevalence in the quarrying and construction industries where workers are exposed to dust when working the local granite which has a high quartz content. Since 1974 a special pneumoconiosis clinic has been dealing with the investigation of cases referred because of chest illness, and the work is com-

Cases of silicosis in jade workers

Case No	Age (years)	Dust exposure (years)	Smoking habit	Radiological classification	Pulmonary function tests				
					FEV ₁ (l/min)	(% predicted)*	FVC (l/min)	(% predicted)*	$\frac{FVC_1}{FVC}$
1	72	33	NS	q1 RU, LM, tba	1.8	(106%)	2.2	(98%)	82%
2	38	22	NS	q3 all zones tbu	2.9	(80%)	3.4	(82%)	91%
3	32	10	NS	q3 all zones tbu	3.4	(87%)	3.5	(79%)	97%
4	27	10	NS	q3 all zones tbu PMF, idA	3.5	(78%)	4.1	(83%)	83%
5	29	5	S	q3 all zones	3.5	(88%)	4.61	(105%)	75%

*Predicted values are obtained from normograms of local male Chinese subjects.

plemented by a medical assessment board in determining the diagnosis and degree of disablement. The clinic routine includes the recording of the occupational histories of all patients. Among several hundred patients with silicosis seen during the past years, five reported their occupation as jade working.

Case reports (table)

CASE 1

A 72 year old man had been a jade worker for 33 years. He had always used a foot pedalled polisher. His radiograph showed discrete micronodular opacities and there was little impairment of pulmonary function. He was also suffering from tuberculosis and diabetes.

CASE 2

A 38 year old man had worked with jade since the age of 16 with both foot pedalled and power driven polishing equipment. He presented with increasing dyspnoea of several years duration and a chest radiograph confirmed the presence of silicotic lesions in all zones (fig 1). Pulmonary function tests showed mild impairment. Investigation at his workplace confirmed high concentrations of airborne silica dust.

Fig 1 Chest radiograph from case 2.

CASE 3

A 32 year old man with 10 years of occupational exposure in jade working using powered equipment had a history of tuberculosis treated in 1970. Silicosis was subsequently discovered in 1983 when he developed a right pneumothorax. His lung function a year after the pneumothorax healed showed mild impairment.

CASE 4

A 27 year old man with 10 years in jade work presented as a case of nephritis and renal failure requiring admission to hospital. Radiography showed silicosis in all zones with progressive massive fibrosis and suspicion of tuberculosis (fig 2). Sputum and urine microscopy and cultures were repeatedly negative for acid fast bacilli. Ventilatory function was impaired.

CASE 5

The 29 year old brother of case 4 who had been employed in the same workshop for the past five years was admitted to hospital suffering from a manic depressive psychosis. Radiography showed profuse silicotic lesions although lung function was as yet little impaired.

Fig 2 Chest radiograph from case 4.

Workplace investigations

The various processes involved in jade carving were studied in a search for the cause of the lung disease. Sawing and drilling generate jade dust but the wet techniques commonly used help to minimise airborne dust concentrations. Polishing, in which silica flour paste was coated on the carving and the rim of a pedestal mounted leather covered wheel which buffs by rotation, was the most dusty process. The paste rapidly dried and dust was ejected by the centrifugal force of the wheel. The result was a dusty environment and, considering the high quartz content of silica flour, generated an obvious hazard to those exposed. It is noteworthy that the present trend to use motor powered tools in jade working achieves much faster wheel speeds with an associated increase in dust production.

The most usual setting for the polishing process is in a corner of the operator's workshop/living room. The windows and doorway usually provide some natural ventilation and there might well be an electric fan to improve air movement or a wall mounted exhaust fan to increase air change but a ventilatory arrangement capable of controlling airborne dust is unlikely. Operators sometimes wear surgical type cotton masks or a piece of towelling over their mouth and nose, but such methods do not provide effective respiratory protection against respirable dust.

Environmental assessment

Measurement of the airborne dust concentration was carried out in the workplace of a confirmed case (case 2). He was reluctant to wear a personal sampling device but since he was sedentary during the buffing operation static sampling with the sample collector positioned near his breathing zone was thought to provide an acceptable alternative. Respirable dust was collected on to PVC membrane filter discs of 0.8 µm pore size, using a Casella sampling device running at a flow rate of 1.9 l/min. The deposited dust was analysed gravimetrically and quartz content determined by x ray diffractometry. A bulk sample of the silica flour was analysed for quartz by infrared spectrophotometry. The silica flour was found to contain 97% crystalline free silica. The silica content of the collected respirable dust was 89%.

The results of the gravimetric analysis of the air samples showed a time weighted concentration of total dust of 1.01 mg/m³ when the recently installed exhaust fan was running; with the fan off the concentration was 5.62 mg/m³. The respirable dust concentrations were 0.34 mg/m³ and 0.72 mg/m³ under the same circumstances. The latter levels were well in excess of the threshold limit value for respirable crys-

talline free silica (0.1 mg/m³ at 89% quartz).¹

Discussion

Depending on the process used, jade working can generate dust from the mineral itself or other materials such as the silica flour used for buffing, as in the present instance. The occupational exposure may have been to a mixed dust, but the high concentration of respirable crystalline silica in the working environment and the clinical findings point to the pulmonary pathology as being that typical of silicosis.

Silica flour is produced by the milling of quartz or quartzite rock and has industrial applications as an abrasive cleaner and as an inert filler. It is found in toothpaste, scouring powder, and metal polish and is also used as an extender of paint, a wood filler, as a component in road surfacing mixtures, and in some foundry processes. The development of silicosis has been reported²⁻⁴ in people using silica flour in various processes as well as in milling.⁵ Rapid progression appears as a common feature and the condition has been described as "galloping silicosis."⁶

The early and rapid onset of the disease was a feature in three patients (cases 3, 4, and 5) in the present series who showed profuse opacities in all zones after an occupational exposure of 5-10 years. The cases presented clinically as accelerated silicosis, which has been categorised as having a 5-15 year exposure period, rather than the acute silicoproteinosis which may also be caused by exposure to silica flour.⁷

The finding of nephritides and renal failure together with progressive massive fibrosis in case 4 is noteworthy. The nephrotoxicity of silica has been suggested in animal studies,^{8,9} and recent reports¹⁰⁻¹² have also recorded renal damage in exposed subjects. Renal biopsy was not carried out in this case but the circumstances raise the possibility of exposure to silica dust as the cause of the renal disease.

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² Soter NA, Wasserman SI, Austen KF. Cold urticaria: release into the circulation of histamine and eosinophil chemotactic factor of anaphylaxis during cold challenge. *N Engl J Med* 1976;294:687-90.

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