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Case Study

Sandblasting under Uncontrolled and Primitive Conditions in Turkey

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Abrasive blasting involves forcefully projecting a stream of abrasive particles onto a surface, usually with compressed air or steam. Since silica sand is commonly used in this process, workers who perform abrasive blasting are often called sandblasters. A material with rough particles should be used in order to have a sufficient effect on resistant surfaces such as glass or metal. Mostly quartz (silicon dioxide=SiO_2) is forced by compressed air onto the target surface[1)]. Although the frequency of the procedure is declining, it is still applied in an uncontrolled fashion in small-scale workplaces (employing fewer than 10 workers). The application in narrow areas, the break up of the SiO_2 particles into smaller pieces when striking the surface and reuse of the same material, increase the respirable dust concentration and this leads to high risk of silicosis [2)].

In our country sandblasting is being done in small-scale workplaces, which would operate as contractors for bigger companies. The purpose of this procedure is to polish the surface of metal, which comes from foundries, and to make the glass dull. The structural features of all workplaces were similar to each other. Although they are in the framework of control mechanisms such as licensing procedures supervised by local public health centers and municipalities, data collection and occupational health & safety inspections and enforcements are not carried out effectively for small-scale companies, so that the actual magnitude of the occupational risks is not known.

In view of these observations, this study was planned with the following aims: to evaluate the work environment and working conditions in small-scale sandblasting workplaces, and to detect the frequency of silicosis among these workers in Turkey.

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Methods

Five small-scale sandblasting workplaces were found in Izmir, Turkey. All workers (11/11) who work in the workplaces were enrolled in the study.

Workers were invited to Dokuz Eylul University Medical Faculty Hospital and the following procedures were done:

a. A form adapted from the "American Thoracic Society Respiratory Symptom Research Questionnaire" was completed by the face-to-face interview method[3)],

b. Chest x-ray and thorax HRCT were taken simultaneously for all workers. Chest x-ray was obtained at maximal inspiration and was evaluated according to the ILO 1980 classification[4)]. HRCT slices were obtained 1.5 mm in thicknesses and at 0.5 cm scan intervals from the apex of the lung to the base of the diaphragm. The images were reconstructed by using a bone algorithm method. All HRCT scan studies were performed on GE Highlight-Advantage.

The profusion of parenchymal opacities seen on the HRCT scan was graded according to the Bergin classification[5)]. Cases with HRCT findings of grade 0 and 1 were not accepted as silicosis.

Working conditions were evaluated in all workplaces. Respirable dust concentrations were measured in each workplace during sandblasting. Measurements were performed with a "Casella AFC 123" individual dust sampler, which could collect especially particles smaller than 5 micrometers. Free silica fractions in dust samples were determined by means of an infrared spectrophotometer. The mineralogical analysis of the sand was done by the X-ray diffraction method.

Results

Eleven (2 female, 9 male) workers were evaluated. Mean age was 31.55 ± 10.79 (range 19–52). All workers (100.0%) were smokers. Mean cumulative cigarette smoking was 25.4 ± 25.2 pack-yr (range: 1–80 pack-yr).

The mean duration of employment in sandblasting was 8.73 ± 6.32 yr (range: 2–20), the mean frequency of work days per year was 211.18 ± 141.72, the mean daily duration of working time was 6.73 ± 2.05 h/d, and the mean cumulative exposure time was $5{,}116 \pm 5{,}453$ h. None of the workers had previous silica exposure in their occupational history. Closed area volumes in which sandblasting was performed in the evaluated five workplaces were 5, 6, 8, 27, 35 m^3 respectively and the mean volume was 16.20 ± 13.85 m^3.

There were no closed ventilation chambers or ventilation hoods but there was a small and ineffective exhaust fan in only 2 of the workplaces. None of the workers used effective preventive equipment during the sandblasting procedure. The usual preventive measure was a fabric mask covering the mouth and nose, except

Table 1. Basic characteristics and clinical findings in the subjects

Case	Age	Sex*	Employment Time (Months)	Weekly Working Days	Daily Working Time (Hours)	Cumulative Exposure (Hours)	Working Area (m^3)	Smoking (pack-year)	Symptoms **	FEV_1 (%Pred)	FEV_1/FVC (%Pred)
O.Y.	33	M	240	7	10	16,800	35	16	1–2–3–4	82	74
L.A.	33	M	156	7	8	8,736	6	19	1–2–4	96	81
A.O.	32	M	228	7	8	12,768	6	40	1–2–4	114	84
M.A.	52	M	84	7	6	3,528	27	64	1–2–4	116	79
A.K.	19	M	60	3	8	1,440	5	1	1–2	124	79
H.D.	24	F	72	1	4	288	5	12	2–3	103	80
H.Y.	27	M	36	7	8	2,016	6	18	1–2–3–4	86	81
A.V.	20	M	96	3	8	2,304	5	10	1–2–3–4	70	78
F.O.	39	M	144	7	6	6,048	5	80	2–4	93	71
S.A.	40	F	60	7	4	1,680	27	15	1–2–3–4	87	70
T.O.	19	M	24	7	4	672	8	5	1–2-3-4	106	87

*M: Male F: Female
**: 1. Cough, 2. Sputum, 3. Wheeze, 4. Dyspnoea on exertion

Table 2. Radiological features of the subjects

Case	Chest x-ray				Thorax HRCT			
	Localization	Size	Intensity	Other	GRADE	Lower	Middle	Upper
O.Y.	Bilateral all zones	q/r	2/2	Coalescence	3	<2 mm nodules	3–5 mm nodules, fibrotic changes vascular distortion	3–5 mm nodules, fibrotic changes, vascular distortion
L.A.	Bilateral, lower-middle zones	p/q	1/0	Inactive tuberculosis	2	Normal	<2 mm subpleural nodules, pleural traction	Fibrotic changes, nodule (1cm), pleural tractions
A.O.	–	–	–	Inactive tuberculosis	2	–	–	(<3 mm) Subpleural nodules, pleural tractions
M.A.	Bilateral all zones	q/q	1/1	–	3	<3 mm subpleural nodules	<3 mm subpleural nodules	Subpleural nodules, pleural tractions, vascular distorsion
A.K.	–	–	–	Normal	0	–	–	–
H.D.	–	–	–	Normal	0	–	Bronchiectasis in middle lobe and lingula	–
H.Y.	–	–	–	Inactive tuberculosis	0	–	–	Inactive tuberculosis
A.D.	–	–	–	Normal	0	–	–	–
F.O.	–	–	–	Normal	0	–	–	Right apical fibrosis, 7 mm nodule
S.A.	–	–	–	Normal	0	–	0.5 cm nodule	–
T.O.	–	–	–	Normal	1	0.2 mm nodule	0.5 mm nodule	0.2 mm nodule

Fig. 1. A view of a small-scale sandblasting workplace

for one worker using an old simple dust mask.

The sand used during the sandblasting contained 85–95% quartz and 5–15% feldspar. The mean respirable dust concentration in the workplace during the sandblasting procedure was found to be 116.42 ± 15.62 mg/m^3 (range: 98.2–137.1). (Permissible maximal level in Turkey: 5.0 mg/m^3). The respirable dust concentration containing free silica was 76.45 ± 7.99 mg/m^3 (range: 65.6–85.4) (Permissible maximal level in Turkey: 0.25 mg/m^3).

On the basis of the questionnaire replies, it was found that all workers had at least one respiratory symptom, for example a cough, sputum, dyspnoea or wheezing. Basic characteristics and clinical findings in the subjects are shown in Table 1.

In 3 of 11 cases (27.2%), findings consistent with silicosis were present on the chest x-ray. In addition to these 3 workers, thorax HRCT revealed one more silicosis case (Table 2). Therefore the frequency of silicosis was found to be 36.3% (4/11) among all sandblasters. The mean working period of these four workers was 9.5 yr (20, 7, 6 and 5 yr respectively).

Discussion

The reported frequency of silicosis seems to be decreasing in the USA [6]. In view of this deduction, one could say that silicosis is no longer a high priority occupational lung disease. Meanwhile, it is proposed that the reported silicosis cases reflect only one third of the actual number of these cases even in developed countries[6]. It is estimated that approximately 1 million workers are under risk of silicosis constitute in the US alone[7]. Generally it is done in small workplaces and these workers constitute only 25.5% of the reported cases of silicosis[8].

The amount of dust to which workers are exposed during the procedure is too much and the workers must work in close contact with the dust cloud (Fig. 1). This situation increases the risk of silicosis development when the preventive measures are inadequate[9]. Although sandblasting with sand containing free silica fraction is restricted in some European countries[10], it is widely used in different workplaces in Turkey since quartz can be provided easily and cheaply. Since a number of non-silica abrasives are available as substitutes, new initiatives are needed for substitution[6].

OSHA's permissible exposure limit for respirable crystalline silica (quartz) is 0.1 mg/m^3 as an 8 h time-weighted average (TWA). The NIOSH's recommended exposure limit for respirable crystalline silica is 0.05 mg/m^3 as a TWA for up to 10 h/d during a 40-h work week[1, 6]. Although the limit of respirable crystalline silica dust exposure is accepted to be 0.05 mg/m^3; the level during abrasive blasting is shown to increase about 200 times[11, 12]. The ratio was approximately 300 times in our study.

Although simple silicosis is known to develop after 20–30 yr of working in other workplaces, the period is only about 10 yr for sandblasting workers[1, 9]. The mean duration of employment of 4 silicosis cases in our study was less than nine years.

Silicosis records in official statistics in Turkey include people covered by the social security system. Since workers in small sandblasting workplaces do not have social security, occupational diseases are not included in official statistics.

In conclusion, the exact incidence of silicosis among sandblasters in our country is not yet known. According to 1983 data, 5.9% of silica-exposed workers are predicted to develop silicosis in the USA where protective measures are applied more effectively[7]. But we found a rate of 36.3% among 11 workers evaluated. In this study a couple of causative factors were found for silicosis: a very high concentration of quartz in the sand, absence of risk control measures such as ventilation systems or closed chambers for sandblasting, absence of effective personal protection, and very high respirable dust concentrations during sandblasting.

Our findings indicate that close attention is needed, especially for small-scale companies, for the prevention and control of silicosis in Turkey and other developing countries.

In view of these results, all workers were informed about the hazardous health effects of quartz and preventive measures, for example; substitute less hazardous materials, use containment methods such as cabinets to control the hazard and protect adjacent workers from exposure, wear protective clothes at the worksite, shower and change into clean clothes after work, use respiratory protective equipment during blasting, the importance of medical screening and not to smoke. Afterwards the results were reported to the local "Occupational Safety and Health Office". We emphasized that silica exposure should be discontinued, as well as quitting smoking and regular medical control for all cases of silicosis.

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