

Rheumatological Diseases in Denim Sandblasters with Silicosis: What Should Pulmonologists Look for?

Elif Altundaş Hatman¹ , Duygu Acar Karagül² , Zeki Kılıçaslan³ 

¹Department of Occupational Medicine, İstanbul Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, İstanbul, Turkey

²Department of Public Health, Occupational Health Training Programme, İstanbul University School of Medicine, İstanbul, Turkey

³Department of Pulmonary Medicine, İstanbul University School of Medicine, İstanbul, Turkey

Cite this article as: Altundaş Hatman E, Acar Karagül D, Kılıçaslan Z. Rheumatological diseases in denim sandblasters with silicosis: What should pulmonologists look for? Turk Thorac J 2020; 21(6): 446-50.

Abstract

OBJECTIVE: Silica exposure is not only the cause of silicosis, also associated rheumatological diseases like rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), and systemic sclerosis (SSc). This report will reveal the rheumatological diseases of silicosis patients who were exposed to silica while working as denim sandblasters. Additionally, we will describe some clinical and laboratory findings that will help pulmonologist suspect, recognize and manage rheumatological diseases related to silica exposure in patients with silicosis.

MATERIAL AND METHODS: We reviewed the records of 142 sandblasters diagnosed with silicosis and found ten silicosis cases who also had rheumatological diseases between the years 2009 and 2017. The occupational characteristics, serological, functional and radiological data, were collected for patients of silicosis with rheumatological diseases.

RESULTS: Ten silicosis patients with concomitant rheumatological diseases were found. Six patients among our cases had diagnosed SSc (4.2%), three of them had RA (2.1%), and one of them was being monitored for SLE (0.7%). The mean silica exposure time of the cases was 4.3 ± 1.9 years (min: 1 max: 8). We also found elevated LD, sedimentation and CRP levels in our cases.

CONCLUSION: It should be kept in mind that, in silicosis cases with arthralgia, joint tenderness or sclerosis at the fingertips may be indicative of rheumatological diseases related to silica exposure, and in these cases, the unexplained elevations of sedimentation and CRP levels may also be a result of silica-induced rheumatological diseases.

KEYWORDS: Silicosis, rheumatological diseases, silica, sandblasters

Received: April 19, 2019

Accepted: August 31, 2019

INTRODUCTION

Crystalline silica exposure is the cause of silicosis, which is an irreversible occupational pulmonary disease, characterized by parenchymal inflammation and fibrotic changes. Recent studies have reported that silica exposure is also associated with rheumatological diseases such as rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), and systemic sclerosis (SSc) [1-3]. It has also been shown that silica exposure may trigger the polyclonal activation of T cells that play a role in the pathogenesis and etiology of rheumatological diseases [4, 5]. This report aimed to study rheumatological diseases of patients with silicosis who were exposed to silica while working as denim sandblasters. In the 2000s, Turkey faced a devastating silicosis outbreak due to silica exposure in the new sector of denim sandblasting [6]. Although the relationship between silica exposure and rheumatological diseases is well-known, no notification has been made regarding denim sandblasters with silicosis and concomitant rheumatological diseases as yet. Additionally, we will delineate some clinical and laboratory findings that will help a pulmonologist suspect, recognize, and manage rheumatological diseases related to silica exposure in patients with silicosis.

MATERIAL AND METHODS

We reviewed the records of 142 sandblasters diagnosed with silicosis and found ten silicosis cases who also had rheumatological diseases between 2009 and 2017. The occupational characteristics and serological, functional, and radiological data were collected for patients with silicosis with rheumatological diseases.

RESULTS

Ten patients with silicosis and with concomitant rheumatological diseases were found (7.0% of all sandblasters in our records), and none of them had a rheumatological diagnosis before silica exposure. Their mean age was 31.8 ± 5.1 years (min

Address for Correspondence: Elif Altundaş Hatman, Department of Occupational Medicine, İstanbul Yedikule Chest Diseases and Thoracic Surgery Training and Research Hospital, İstanbul, Turkey

E-mail: elifaltundashatman@istanbul.edu.tr

©Copyright 2020 by Turkish Thoracic Society - Available online at www.turkthoracj.org

25, max 40) at the time of the silicosis diagnosis. Six patients among our cases had diagnosed SSc (4.2%), three of them had RA (2.1%), and one of them was being monitored for SLE (0.7%). The mean silica exposure time of the cases was 4.3 ± 1.9 years (min 1, max 8). While the respiratory symptoms of the workers occurred for a mean of 6.8 ± 3.8 years (min 1, max 13) after the end of exposure, the rheumatological complaints occurred after 9.5 ± 3.8 years (min: 3, max: 15) except for Case 6. Only Case 6 had started to experience complaints of both dyspnea and arthralgia when he worked as a denim sandblaster, three years after the first exposure. The distribution of the demographic characteristics, exposure duration, and radiographic and lung function parameters of all the cases are summarized in Table 1, whereas the symptoms, physical findings, serology, and clinical diagnoses of the rheumatological diseases of all cases are summarized in Table 2. The clinical reports on the cases are given as follows.

Silicosis with Systemic Sclerosis

Case 1, a 26-year-old male patient presented with a history of exertional dyspnea for the past two years and dysphagia, arthralgia, and sclerosis in the fingertips for a year. Disruption in peristalsis was found in esophagography. The echocardiography was normal.

Case 2, a 25-year-old male patient was referred for the Modified Medical Research Council (mMRC) level 1 dyspnea for three years. He also had complaints of erectile dysfunction, arthralgia, and cyanosis in the hands which started nearly a year ago. The echocardiography was normal.

Case 3, a 31-year-old male patient had mMRC level 1 dyspnea for seven years, wound on the hands, and erectile dysfunction complaints for a year. The echocardiography was normal.

Case 4, a 33-year-old male patient was referred for mMRC level 2 dyspnea and diagnosed with silicosis. He had been diagnosed with SSc one year ago with complaints of cyanosis and sclerodactyly.

Case 5, a 33-year-old male patient died from respiratory failure approximately five years after being diagnosed with silicosis. He had also been treated for pulmonary tuberculosis before referral. The patient had mMRC level 4 dyspnea, loss of weight, and sclerosis in the fingertips. The echocardiography revealed pulmonary hypertension and presence of pericardial fluid. Respiratory acidosis and hypoxemia were found in the arterial blood sample.

Case 6, a 40-year-old male patient had mMRC level 1 dyspnea, pain, coldness and cyanosis in the hands, and sclero-

dactyly. He had been diagnosed with silicosis six years ago. He had rheumatological complaints for four years and was diagnosed with SSc four years ago.

Silicosis with Rheumatoid Arthritis

Case 7, a 30-year-old male denim worker was referred for dyspnea eight years ago, and he diagnosed with silicosis. He started to have complaints of pain and swelling in his knees, joints of hands and feet three years later following the diagnosis of silicosis.

Case 8, a 28-year-old male patient presented with a history of exertional dyspnea for the past three years. He was also diagnosed with RA three years ago while he was working as a denim sandblaster.

Case 9, a 41-year-old male patient had mMRC level 2 dyspnea for five years. He also had complaints of arthralgia and swelling in his ankle joint. He was diagnosed with RA three years ago.

The RA cases also had high levels of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), which were unexplained by other clinical conditions. The patients were evaluated by using rheumatology and diagnosed with high levels of anti-cyclic citrullinated peptide (anti-CCP) and a positive rheumatoid factor (RF) test given in Table 2.

Silicosis with Systemic Lupus Erythematosus

Case 10, a 32-year-old man was referred for mMRC level 3 dyspnea, weight loss, and weakness three years ago, and he started to have complaints of diplopia three months ago. He also had high levels of LD, ESR, and CRP. The patient's immunological laboratory test results were compatible with SLE. His neurological comorbidity was considered to be secondary to his immunological disease.

The diagnoses of silicosis of the cases that were classified according to the International Labor Organization (ILO) International Classification of Radiographs of Pneumoconiosis are given in Table 1. Apart from Case 10, all the cases had restrictions in respiratory function tests, whereas Case 4 had a mild obstruction. We determined that the majority of cases had inspiratory and/or expiratory crackles on lung auscultation because of severe interstitial lung disease.

The LD level was found to be high in the four SSc cases. The LD level of case 5 was high, about four times the upper limit. All SSc cases had high levels of ESR and CRP, which were unexplained by other clinical conditions. The median ESR was 57 mm/h (0-10 mm/h; min 26, max 81), and the median CRP level was 31.6 mg/l (0-0.5 mg/l; min 3.5, max 119.8). The patients who had been evaluated by using rheumatology and diagnosed with high levels of anti-Scl 70 (anti-DNA topoisomerase I) and positive anti-nuclear antibody (ANA) as a result of the tests are shown in Table 2.

CONCLUSIONS

The cases of rheumatological diseases diagnosed in workers with silica exposure in different sectors are found in the literature with or without silicosis. In addition to miners and drillers, stonemasons [7], dental technicians [8, 9], and pot-

MAIN POINTS

- Silicosis cases with arthralgia, joint tenderness, or sclerosis at the fingertips may be indicative of rheumatological diseases related to silica exposure.
- The unexplained elevation of ESR and CRP levels in each cases may also be a result of silica-induced rheumatological diseases.
- Diagnosis of occupational rheumatological disease entitles the worker to additional compensation.

Table 1. Distribution of demographics, occupation, exposure time, radiographic and lung function parameters of cases

Case number	Silicosis Diagnose age	Duration of exposure (years)	Radiographic findings by chest radiograph	ILO International Classification of Radiographs of Pneumoconiosis	FEV1% Predicted	FVC% Predicted	FEV1/FVC Predicted	DLCO	TLC
1	26	8	Diffuse reticulonodular imaging, massive fibrosis in right lung	qr 2/2 with A opacity	60%	69%	76	56%	
2	25	1	Diffuse reticulonodular imaging, mediastinal lymphadenopathy, egg-shell calcification	pq 2/2	66%	78%	71	69%	
3	30	5	Diffuse reticulonodular imaging with upper lobe dominance	qr 3/3 with C opacity	44%	40%	92	45%	46%
4	37	5	Diffuse reticulonodular imaging, progressive massive fibrosis, mediastinal lymphadenopathy with calcification	rr 3/3	69%	81%	73	-	
5	33	5	Diffuse reticulonodular imaging, mediastinal lymphadenopathy	qq 2/2 with A opacity	96%	122%	67	74%	92%
6	46	5	Diffuse reticulonodular imaging, mediastinal lymphadenopathy	qq 3/2	77%	84%	75	-	
7	30	2	Diffuse nodular imaging	qq 2/3	82%	86%	80	93%	82%
8	28	4	Diffuse reticulonodular imaging	pp 2/2	81%	94%	90	72%	
9	41	2	Diffuse reticulonodular imaging with upper lobe dominance	ps 2/2	92%	88%	77	-	
10	25	3	Diffuse reticulonodular imaging, progressive massive fibrosis, mediastinal lymphadenopathy with calcification	qq 3/3 with A opacity	63%	74%	72	-	

tery makers [10] are examples of some of the affected worker groups diagnosed with silicosis and/or rheumatological diseases so far. This study shows another under-risk group of workers who were exposed to silica and diagnosed with various rheumatological diseases and silicosis due to their work in denim sandblasting.

The frequency of rheumatological diseases due to silica exposure in different studies shows a wide variety. A study among fifty scouring powder factory workers reported SSc prevalence as 10% (5/50), SLE prevalence as 6% (3/50), and overlap syndrome (SLE/SSc) prevalence as 10% (5/50) [11]. A cross-sectional study that was carried out in Israel showed that 23% (9/40) of workers who had silica exposure had various rheumatological diseases, and one-third of them had SSc [12]. A report from the state of Michigan Surveillance System for Silicosis evaluated 790 silicosis cases and reported the prevalence of rheumatological diseases as 5.5% (44/790), RA prevalence as 4.2% (33/790), SSc preva-

lence as 0.3% (2/790), and SLE prevalence as 0.1% (1/790) [13]. In our series, 7% of all recorded denim sandblasters had rheumatological diseases. Six patients among the cases in our study were diagnosed with SSc (4.2%), three of them had RA (2.1%), and one of them was being monitored for SLE (0.7%).

Most of the published data show that the effects of chronic silica exposure (mean exposure time differences between 14.9 and 20 years) are associated with rheumatological diseases [13-16], while there is a limited number of studies on the acute effects of silica exposure [7-11]. A case series from Algeria [7] reported that mean exposure time in nine stone-masons was 4.8 ± 1.1 years. Similarly, in our series, we describe acute silica exposure of 4.3 ± 1.9 years (min 1, max 8) in sandblasters. The mean duration of exposure in scouring powder factory workers with rheumatological diseases [11] was 6.1 years. In contrast, we showed a longer latency period from last exposure until the appearance of symptoms as

Table 2. Distribution of symptoms, physical findings, serology and clinical diagnoses of rheumatologic diseases of cases

Case Number	Symptoms	Physical Findings	Relevant Serology	Clinical Diagnoses	ESR (mm/h)*	CRP (mg/L)**	LD (U/L)***
1	Dyspnea, thickening in fingertips, arthralgia	Sclerosis in fingertips, Inspiratory and expiratory crackles in lung auscultation	ANA:+ Anti Scl-70 :248.66	Systemic Sclerosis	57	12.66	672
2	Dyspnea, arthralgia, cyanosis, Reynaud Phenomenon, impotence,	Inspiratory crackles in lung auscultation	ANA: +	Systemic Sclerosis	27	13.00	236
3	Dyspnea, Fissures and thickening in fingertips, impotence	Sclerosis in Fingertips Inspiratory and expiratory crackles in lung auscultation	ANA: + Anti Scl-70:95	Systemic Sclerosis	70	119.85	346
4	Dyspnea, palpitation, cyanosis thickening in fingertips, weakness	Sclerosis in Fingertips Increased respiratory rate, hypoxemia Inspiratory and expiratory crackles in lung auscultation	RF:26.9	Systemic Sclerosis	81	42.66	1004
5	Dyspnea, weakness	Inspiratory crackles in lung auscultation	ANA: + RF:11.0	Systemic Sclerosis	26	32.00	155
6	Dyspnea, thickening in fingertips	Inspiratory crackles in lung auscultation Sclerosis in Fingertips	ANA: + Anti Scl-70: 120	Systemic Sclerosis	-	3.50	254
7	Dyspnea Hand, foot and knee pain	Inspiratory crackles in lung auscultation Joint Precision	RF:455.0 Anti CCP:79	Rheumatoid Arthritis	34	137	270
8	Dyspnea, arthralgia	Inspiratory crackles in lung auscultation Joint Precision	ANA: + RF: 22	Rheumatoid Arthritis	-	-	-
9	Dyspnea, arthralgia	Joint Precision	ANA: + RF:10.7	Rheumatoid Arthritis	-	17.60	-
10	Dyspnea, arthralgia, diplopia, dizziness and imbalance	Inspiratory and expiratory crackles in lung auscultation	ANA: +, Anti-ds-DNA:+	Systemic Lupus Erythematosus	91	9.17	551

* Theme Linear system. Infrared barrier method. Range of normal value of ESR:0-10 mm/h

** Roche/Hitachi COBAS C system. *In vitro* quantitative test. Immunoturbidimetric measurement. Range of normal value of CRP:0-0.5 mg/L

*** Roche/Hitachi COBAS C system. *In vitro* test, photometry measurement. Range of normal value of LD 135-250 IU/L

9.5±3.8 years (min 3, max 15) for the rheumatological symptoms and 6.8±3.8 years (min 1, max 13) for the respiratory symptoms.

The latency period from the first exposure until the appearance of symptoms of rheumatological diseases in stonemasons was found to be 5.8±1.3 years. The difference in the latency periods may be due to various factors such as amount of exposure, individual factors, and genetic factors.

We also found elevated LD, ESR, and CRP levels in our cases. LD is an intracellular enzyme which increases in blood plasma when tissues are damaged by an injury or disease. A case-control study reported that denim sandblasters with complicated silicosis have a high levels of LD in comparison with those with simple silicosis and healthy groups, and they suggested that LD levels might be considered as a marker of pulmonary parenchymal involvement in patients (17). Similarly, four of five complicated silicosis cases in our series (cases 1, 3, 5, 9 and

10) had high levels of LD. Moreover, all cases had high levels of ESR and CRP, which were unexplained by other clinical conditions.

This report is valuable not only for showing 10 silicosis cases caused by denim sandblasting with three different comorbid rheumatological diseases related to silica exposure but also for describing elevated ESR and CRP levels, which could not be explained by other reasons in patients with silicosis and may be indicators of rheumatological diseases associated with silica exposure. We also recommended that the workers' compensation rates be calculated again as rheumatological diseases related to silica exposure affect the level of workers' compensation.

It should be kept in mind that silicosis cases with arthralgia, joint tenderness, or sclerosis at the fingertips may be indicative of rheumatological diseases related to silica exposure, and in these cases, the unexplained elevation of ESR and CRP levels may also be a result of silica-induced rheumatological diseases.

Informed Consent: Written informed consent was obtained from the patients or relatives of dead patients.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - E.A.H., Z.K.; Design - E.A.H., Z.K., D.A.K.; Supervision - E.A.H., Z.K.; Resources - E.A.H., D.A.K.; Materials - E.A.H., Z.K., D.A.K.; Data Collection and/or Processing - E.A.H., Z.K., D.A.K.; Analysis and/or Interpretation - E.A.H., D.A.K.; Literature Search - E.A.H., D.A.K.; Writing Manuscript - E.A.H., Z.K., D.A.K.; Critical Review - E.A.H., Z.K., D.A.K.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Blanc PD, Järholm B, Torén K. Prospective risk of rheumatologic disease associated with occupational exposure in a cohort of male construction workers. *Am J Med* 2015;128:1094-101. [\[CrossRef\]](#)
2. Miller FW, Alfredsson L, Costenbader KH, et al. Epidemiology of environmental exposures and human autoimmune diseases: Findings from a national institute of environmental health sciences expert panel workshop. *J Autoimmun* 2012;39:259-71. [\[CrossRef\]](#)
3. Lee S, Hayashi H, Mastuzaki H, et al. Silicosis and autoimmunity. *Curr Opin Allergy Clin Immunol* 2017;17:78-84. [\[CrossRef\]](#)
4. Lee S, Matsuzaki H, Kumagai-Takei N, et al. Silica exposure and altered regulation of autoimmunity. *Environ Health Prev Med* 2014;19:322-9. [\[CrossRef\]](#)
5. Pollard KM. Silica, silicosis, and autoimmunity. *Front Immunol* 2016;7:97. doi: 10.3389/fimmu.2016.00097. eCollection 2016. [\[CrossRef\]](#)
6. Akgun M, Araz Ö, Yilmazel Ucar E, et al. Silicosis appears inevitable among former denim sandblasters: A 4-year follow-up study. *Chest* 2015;148:647-54. [\[CrossRef\]](#)
7. Slimani S, Ben Ammar A, Ladjouze-Rezig A. Connective tissue diseases after heavy exposure to silica: A report of nine cases in stonemasons. *Clin Rheumatol* 2010;5:531-3. [\[CrossRef\]](#)
8. Iannello S, Camuto M, Cantarella S, et al. Rheumatoid syndrome associated with lung interstitial disorder in a dental technician exposed to ceramic silica dust: A case report and critical literature review. *Clin Rheumatol* 2002;1:76-81. [\[CrossRef\]](#)
9. Astudillo L, Sailler L, Ecoiffier M, et al. Exposure to silica and primary Sjögren's syndrome in a dental technician. *Rheumatology* 2003;10:1268-9. [\[CrossRef\]](#)
10. Turner S, Cherry N. Rheumatoid arthritis in workers exposed to silica in the potter industry. *Occup Environ Med* 2000;57:443-7. [\[CrossRef\]](#)
11. Sanchez-Roman J, Wichmann I, Salaberri J, et al. Multiple clinical and biological autoimmune manifestations in 50 workers after occupational exposure to silica. *Ann Rheum Dis* 1993;52:534-8. [\[CrossRef\]](#)
12. Shtraichman O, Blanc PD, Ollech JE, et al. Outbreak of autoimmune disease in silicosis linked to artificial stone. *Occup Med* 2015;65:444-50. [\[CrossRef\]](#)
13. Makol A, Reilly MJ, Rosenman KD. Prevalence of connective tissue disease in silicosis (1985-2006)- A report from the state of Michigan surveillance system for silicosis. *Am J Ind Med* 2011;4:255-62. [\[CrossRef\]](#)
14. Aminian O, Sharifian S, Mehrdad R, et al. Antinuclear antibody and rheumatoid factor in Silica-Exposed workers. *Arh Hig Rada Toksikol* 2009;2:185-90. [\[CrossRef\]](#)
15. Stolt P, Källberg H, Lundberg I, et al. Silica exposure is associated with increased risk of developing rheumatoid arthritis: Results from the Swedish EIRA study. *Ann Rheum Dis* 2005;4:582-6. [\[CrossRef\]](#)
16. Miranda AAM, Nascimento AC, Peixoto IL, et al. Erasmus syndrome: silicosis and systemic sclerosis. *Rev Bras Reumatol* 2013;53:310-3. [\[CrossRef\]](#)
17. Deniz O, Gumus S, Ors F, et al. Serum lactate dehydrogenase levels significantly correlate with radiological extent of disease and spirometric values in patients with silicosis due to denim sandblasting. *Clin Chem Lab Med* 2012;50:483-8. [\[CrossRef\]](#)