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Original Article

Humoral Immune System Alterations in Silica Exposed Workers

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Abstract

Background: Crystalline silica may act as an immune adjuvant to increase inflammation and antibody production. The highest exposures to silica are known to occur in the dusty trades industries such as stone- cutting. We undertook this population based study to examine the association between occupational silica exposure and humoral immune system.

Methods: In this historical cohort study, 47 workers from 10 stone-cutting factories in Rey City, south of Tehran, Iran that had more than 10 years exposure to silica were included in case group and 45 individual without any exposure to silica were selected for control group. We measured serum immunoglobulins (IgM, IgG, and IgA) of participants with ELISA method and compared the results between exposed workers and control groups.

Results: The mean concentrations of two immunoglobulines (IgG, IgA) and IgM in case group in comparison with control group were higher and lower respectively but both were in normal range. IgA concentration between two groups was statistically significant ($P< 0.05$).

Conclusion: Crystalline silica exposure may promote the humoral immune system in some individuals. Additional research is recommended in other population, using study design that minimize potential selection bias and maximize the quality of exposure assessment.

Keywords: *Silica, Humoral immunity, Stone-cutting, Iran*

Introduction

The abundance of silica in the environment is second to oxygen and is one of the most documented workplace contaminants (1). Although several other chemical exposures have been documented, stone- cutting workers are some of the main industries in which crystalline silica represents the major potential air contaminants (2-5). The most common health effect of occupational exposure to crystalline silica is silicosis, which remains the most common pneumoconiosis worldwide. The prevalence of this illness peaked in the last half of the 19th century and the early part of the 20th century, when mechanized industry was developing and the relationship between dust exposure and disease was less well understood. Yet, even today in developed countries, sporadic outbreaks of silicosis occur when workers are consistently exposed to silica particles of respirable size (0.5-5.0 μm in diameter) at levels exceeding those recognized to be safe (3, 4). Increasing experimental and clinical evidence indicates that the immune system is a target physical and chemical agents found in the workplace (6).

Inflammatory responses resulting from workplace exposures are usually observed in specific target organs, such as the lungs, skin and liver and, if persistent, may progress to fibrosis, granolomatous diseases or even cancer (6). Examples of workplace agents that induce chronic inflammation in the lung include fibers, such as silica and asbestos (6-8).

Long term exposure to silica has been reported to be the principle cause of silicosis and other chronic abnormalities and it has been suggested that silica related diseases are associated with alteration of cellular and humoral immune func-

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tions (6, 8). Occupational exposure to crystalline silica dust has been examined as a possible risk factor with respect to several systemic autoimmune diseases, including rheumatoid arthritis, scleroderma, systemic lupus erythematosus and some of the small vessel vasculitis with renal involvement (8-10). Hypergammaglobulinemia, the presence of autoantibodies and circulating immune complexes have been demonstrated in mineral dust exposed workers who have developed mineral dust- related disorders (2, 11). There is in vivo evidence for both enhancement and depression of immune responses after exposure to silica (2).

Major aim of the presence study was to assess the immune competence of stone- cutting workers occupationally exposed to silica.

Materials and Methods

Study subjects

The immunoglobulines of peripheral blood of 47 male stone- cutting workers occupationally exposed to silica in small plants that were located in south of Tehran, were measured and compared with that of 45 male unexposed to silica subjects of comparable age and smoking habits with no history of silica and other chemical exposure, employed in administrative government offices of the Tehran University of Medical Sciences.

The age range of the silica exposed stone- cutting workers was 26-69 yr (42±10) and of controls was 28-56 yr (42±8). The mean duration of occupational exposure to silica was 16±7 yr with a range of 10-35 yr.

The mean and standard deviation of occupational exposure to silica was 16±7 yr with a range of 10-35 yr**.**

From the questionnaire on protective measures, we found that nearly all of the workers in our study had not taken the necessary and suitable protective precautions in their workplace and they claimed no complaint on any diseases including bronchitis, coughing or other respiratory abnormalities.

All subjects participated voluntarily and all provided written agreement before blood samples were drawn from them. A questionnaire was designed to yield information on previous medical and occupational history, frequency of infectious diseases, drug usage, and smoking. Duration of occupational exposure, work characteristics of the exposed workers, such as the use of protective equipment (mask) were also investigated.

Sample collection

A 5 ml peripheral blood sample was taken from each individual and allowed to clot, for the measurement immunoglobulin, IgM, IgG, IgA. The serum samples were kept at -70° C until they were analyzed. Serum concentrations of IgM, IgG, and IgA were measured in serum using ELISA.

Analysis

Results are expressed as mean±standard errors except where indicated. Two- way comparisons between silica- exposed and immunoglobulin levels were performed using unpaired *t*-test for normally distributed data or Mann- Whitney rank sum tests for data that were not normally distributed. Data were entered and analyzed by SPSS 11.5. Differences were considered significantly different at a level of $P< 0.05$.

Results

The individuals, who entered this study, did not have enough information about the necessity of a ventilation system in the factory, and also using personal protective devices. They used only non-standard surgical masks, and some of them did not use any protective device. The ventilation systems of these factories were not efficient at all, and the average concentration of crystalline silica was high. Thus there was not any statistically significant difference between test results of those who used and those who did not use personal protective devices.

The average consumption of cigarettes in stonecutting workers and their controls was 8 ±8 and 2±6 pack yr, respectively. 57.4% of exposed workers (31 persons), and 53.3% of unexposed workers (24 persons), were smokers. There were no

statistically significant relationships between smoking status and IgA between two groups.

Table 1 gives the serum immunoglobulin levels in silica-exposed workers and controls. Serum IgM were found to be depressed in stone- cutting workers compared to controls but no significant differences was observed. (101±38 in comparison with 114±56). Difference in concentration of IgA between two groups was statistically significant (285±84 in comparison with 249±88; $P= 0.04$).

Table 1: Serum immunoglobulin concentrations of silica exposed workers and controls (mean±SD)

Immunoglobulin (mg/dl)	case group (n = 47)	control group (n = 45)	*P*
IgM (40-230)	101±38 (27 - 177)	114±56 (40 - 256)	0.2
IgG (700-1600)	1445±203 (876 - 1994)	1404±243 (889 - 2068)	0.37
IgA (70-400)	285±84 (128 - 539)	249±88 (85 - 425)	0.04

Discussion

In addition to improper ventilation systems and not using proper protective devices, there was exposure to other pollutants in the work environment, which affects various organs, especially immune system, although because the concentration of theses pollutants was low, and they were not the interest of this study, we did not evaluate them. But it must be emphasized that these pollutants can induce a complicated complex of responses in immune system and have a confounding effect.

Available information about the effects of exposure to silica on humoral immunity was scant. According to some of previous studies, exposure to crystalline silica can stimulate humoral immune system (11-13), but some other studies have concluded that this exposure will suppress humoral immune system (2). The theory is that exposure to silica at first will suppress humoral immune system, and chronic exposure to silica (and silicosis) will stimulate the immunity.

In this study the average concentration of IgA in exposure and non-exposure groups was normal, but it was higher in exposure group (285±84 mg/dl) than non-exposure group (249±88 mg/dl) and the difference between two groups was statistically significant ($P< 0.05$). Although in 4 individuals IgA concentration was higher than normal value.

This finding was consistent with the previous studies (11-14); which mentioned that IgA played an important role in the pathogenesis of silicosis. As it is expected, chronic exposure of mucous membranes to silica and stimulation of immune system in this region, IgA concentration has increased (15).

In this study, average concentration of IgG and IgM in exposure and non-exposure groups was normal, though average concentration of IgG in exposed workers was higher than unexposure group; there was not any statistically significant difference between two groups. As mentioned earlier, changes in immunity have been surveyed only in silicotic individuals whose exposure duration has been 20-30 yr, but we considered 15 yr as average exposure duration and also exposure to silica was our variable, not silicosis. Thus it's expected that increase or decrease in immunity (especially increase) is not prominent. Significantly higher levels of IgG were observed in silicosis patients. (16-18).

Because of widespread use of silica-containing material and abundance of silica in earth's crust, there are many occupations with exposure to silica, such as pottery, mining, rock-drilling, etc. (2). Nowadays thanks to the better ventilation systems in plants and factories, exposure to crystalline silica in work environment have been reduced (2).

Conclusively, in stone-cutting factories which we studied, in spite of improved hygiene in the workplace in recent years and application of wet systems for reducing dust, unfortunately exposure to crystalline silica is yet higher than Recommended Exposure Level (REL).

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The authors declare that they have no Conflict of Interests.

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