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Role of Interleukin 1- Alpha in Pulmonary Toxic Effect among Silica Exposed Workers

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Abstract:
Background: Silicosis refers to a spectrum of pulmonary diseases attributed to inhalation of free crystalline silicon dioxide. It entails inflammatory response in which Interleukin-1 alpha is a key mediator. **Objectives**: to evaluate the role of interleukin-1α (IL-1α) as a biochemical marker for detection of pulmonary toxic effects of silica in relation to clinical and radiological manifestations among exposed workers. **Methods**: The study was conducted on 64 male workers exposed to silica dust assigned to El-Harareyat Factory of Alexandria. An interviewing questionnaire was used to collect data about personal, occupational and medical characteristics. Pulmonary function testing, plain chest radiographs and laboratory assessment of serum level of IL-1α were done for all workers. IL-1α was assessed also among a matched control group. **Results**: Prevalence of silicosis was 37.5%. Serum IL-1α level among silica-exposed workers was 2.8±1.8 pg/ml while it was undetected among a control group of healthy males. IL-1α was positively correlated with wheezes, negatively correlated with FVC, FEV1, MMEF, $FEF_{50\%}$, positively correlated with extent of nodular opacities in lung zones and presence of enlarged and calcified hilar lymph nodes. **Conclusion**: IL-1α can be a good monitoring marker for the earliest sign of silicosis; hilar lymphadenopathy.

Keywords: silica, Interleukin-1 alpha, pulmonary, toxicity, occupational

INTRODUCTION

Silicosis refers to a spectrum of pulmonary diseases attributed to inhalation of various forms of free crystalline silicon dioxide.(1) It has been estimated that a great number of new silicotic cases is being diagnosed annually all over the world. Among European countries, it was revealed that Germany has the highest number of new cases. In Asia, prevalence of silicosis is up to 55% among exposed workers, while in Latin America, the

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prevalence is up to 37%.[2]

Silicosis is the most common occupational lung disease in Egypt. Its prevalence ranges from 18.5% to 45.8% among silica exposed workers in different industries.[3] The Egyptian Ministry of Health and Population reported in 2003 that there were 3001 cases of silicosis among 48154 workers who were examined and investigated.[4]

Pathogenesis of silicosis entails an inflammatory process in which release of different inflammatory mediators occurs. These mediators in turn provoke recruitment of various inflammatory cells into alveolar wall and alveolar epithelial surface.[5]

A key mediator of host response to various infectious inflammatory and immunologic challenges is Interleukin-1 alpha (IL-1α). IL-1α possesses a wide range of activities as it acts on macrophages and monocytes, inducing its own synthesis as well as production of various mediators.[6]

However, inappropriate or prolonged production of IL-1α has been implicated as playing a role in production of pathological conditions as fibrosis and tissue matrix breakdown.[7] Furthermore, IL-1α has a role in pulmonary toxicity where its release was associated with development of pulmonary granulomas after exposure to crystalline silica dust.[6, 7]

Clinical diagnosis of silicosis is greatly dependent on detection of radiological abnormality, which is considered as a late and irreversible manifestation of the disease.[8] Therefore, if the worker was proven to have permanent partial disability then he should be transferred to another place with less exposure to silica and the employer is obliged to pay him his full salary. If he was proven to have permanent total disability, he received a monthly compensation which is equal to his full salary.[9]

As silicosis is not a curable disease, it is of great interest and practical consequence to investigate the possibility of using a

biological response that accompanies silicosis as prospective markers for the disease. In addition, it is of importance to assess such biological responses before the threshold burden of silica in the lung has been exceeded resulting in progressive pulmonary disease.

The present study was conducted to evaluate the role of interleukin-1α as a biochemical marker for detection of pulmonary toxic effects of silica in relation to clinical and radiological manifestations among exposed workers.

SUBJECTS AND METHODS:

Study design, setting and period:

A cross sectional comparative approach was selected. Target population was workers exposed to silica dust who were referred from different departments of El-Harareyat Factory of Alexandria to the Occupational Health Clinic in Gamal Abd El-Naser Health Insurance Hospital for periodic examination during the period of the study. The workers were recruited in the Occupational Health department affiliated to Gamal Abd El-Naser Health Insurance Hospital in Alexandria.

The exclusion criteria were history of current smoking or cessation of smoking for less than one year, suffering from systemic diseases that could affect pulmonary function testing, suffering from systemic diseases that could result in increased production of interleukin-1α as multiple sclerosis, rheumatoid arthritis and insulin dependent diabetes mellitus.[10] Moreover, workers employed for duration less than one year and those who had history of exposure to any other respiratory irritants or chemicals were also excluded.

Thirty male workers were enrolled in the study during the period from 1st of February 2010 till 30th April 2010. Target population was increased by involving another 34 male workers during the period between 1st of September till 31st December 2010 to increase power of the study. Thus, total enrolled subjects; 64 male workers, constituted all

workers attending for periodic examination at the period of the study and fulfilling the inclusion criteria of the study. Meanwhile, 79 workers were excluded from the study on applying the exclusion criteria.

A control group of 60 healthy non-smoker male individuals was recruited in the study from administrative departments in the Faculty of Medicine. They had no history of previous or current exposure to silica dust or any other respiratory noxious materials.

Data collection tool:

A. Silica exposed workers:

An interviewing questionnaire was developed after reviewing literature to collect data about personal characteristics, occupational history (department, duration of exposure to silica and usage of protective equipment), and medical history of respiratory complaints.

Moreover, all silica exposed workers were subjected to clinical examination with special emphasis on chest examination.

Pulmonary function testing was conducted to all workers exposed to silica dust using automatic dry spirometer, manufactured by Jaeger Company, Germany. The equipment used met the recommended standardizations cited by the American Thoracic Society (ATS) and the European Respiratory Society.

Moreover, plain postero-anterior (PA) chest radiographs were examined for each exposed worker independently by two readers based on the International Labour Organization (ILO) classification to describe and codify the radiographic abnormalities of pneumoconiosis.[11]

Laboratory assessment of serum level of IL-1α was done using blood samples collected from all silica-exposed workers so as their controls. Enzyme-linked immunosorbent assay (ELISA) technique was then employed for the analysis at the Clinical Pathology Department, Faculty of Medicine, University of Alexandria. The kit used was Human IL-1α ELISA kit, Bender Med Systems GmbH Campus Vienna Biocenter 2A-1030 Vienna, Austria, Europe.

B. Control group: Similar interviewing schedule was used to collect data about personal characteristics and medical history. In addition, laboratory assessment of serum level of interleukin 1α was conducted.

A pilot study was conducted on 5 randomly selected workers who were excluded from the main study. Some questions were rephrased.

Ethical considerations

The research protocol was approved by Alexandria Faculty of Medicine Ethics Committee so as the committee of research ethics affiliated to Health Insurance in Alexandria. An Informed consent was obtained from all individuals before participation in the study. Objectives of the study were clarified to all participants and their privacy was guaranteed.

Statistical analysis:

Raw data was coded, entered and analyzed using SPSS system files (SPSS package version 18). Data was described using frequency; distribution, trimmed mean, and standard deviation. Normality of data distribution was tested using Kolmogorov – Smirnov test. Univariate analyses were conducted using t-test and Mann Whitney test for quantitative variables while Yates-corrected Chi-square test for qualitative variables.

Linear correlation using Spearman Rho correlation coefficient was used to delineate association between serum IL-1α and different personal, occupational, ventilator, and radiologic characteristics of studied workers exposed to silica dust.

Moreover, ROC curve was used to calculate cutoff point of IL-1α to diagnose occurrence of lymphadenopathy among silica exposed workers. The significance of the results was at the 5% level of significance.

RESULTS

The study was conducted on 64 male workers exposed to silica assigned to different departments in El-Harareyat Factory of

Alexandria namely; packaging department (42.1%), maintenance department (17.2%), calcining department (14.1%), furnaces (14.1%), and millers department (9.4%). Only two workers were in the silica clay department (3.1%). (Figure 1)

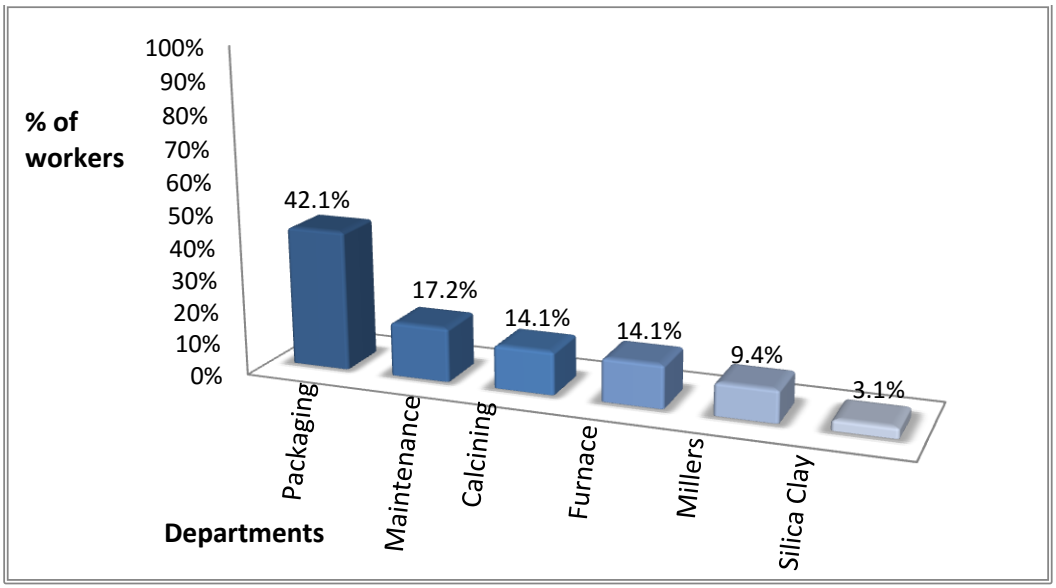


Figure (1): Distribution of silica-exposed workers according to departments of the factory

Duration of exposure to silica:

Workers were exposed to silica dust for a duration that ranged from 5 to 27 years with a mean of 10.3±2.9 years; (Table 1). None of the studied workers gave history of using respiratory protective devices.

Table (1): Distribution of silica-exposed workers according to occupational history and respiratory complaints

	Silica-exposed workers (n=64)	
Personal characteristics		
Age (years)	24-53 (33.1±5.2)	
Occupational history		
Duration of exposure to silica (years)	5-27 (10.3±2.9)	
Respiratory manifestations		
Cough	**No.**	**%**
Absent	20	31.2
Present	44	68.8
Dry cough	4	6.3
Productive cough	40	62.5
Wheezes		
Absent	40	62.5
Present	24	37.5
Dyspnea		
Absent	42	65.6
Present	22	34.4
Chest pain		
Absent	45	70.3
Present	19	29.7

Respiratory manifestations among silica-exposed workers:

Respiratory manifestations in the form of cough (68.8%), wheezes (37.5%), dyspnea (34.4%), and chest pain (29.7%) were recorded among the workers; (Table 1).

Results of pulmonary function tests among silica-exposed workers:

Results of pulmonary function testing revealed reduced mean of maximum voluntary ventilation (MVV); (52.7±19.5 L/min) so as peak expiratory flow (PEF) (55.9±18.7 L/S). (Table 2)

As regards forced expiratory flow rates ($FEF_{25\%}$), ($FEF_{50\%}$), and ($FEF_{75\%}$), they showed <80% reduction of the predicted value in 37.5%, 46.9% and 50.0% of the studied workers, respectively. Additionally, forced vital capacity (FVC) and forced expiratory volume at one second (FEV_1) showed <80% reduction of the predicted value in 28.1% and 23.4%, of the studied

workers, respectively. Furthermore, nearly a quarter of the workers showed <80% reduction of the value of FEV_1/FVC ratio. (Table 2)

Table (2): Distribution of silica-exposed workers according to results of pulmonary function testing and chest x-ray findings:

Pulmonary function tests (% of predicted value)	Silica-exposed workers (n=64) Range	Trimmed Mean±SD	<80%		80%-100%		>100%	
			No.	%	No.	%	No.	%
FVC	59.7-126.9	80.5±14.8	18	28.1	34	53.1	12	18.8
FEV_1	42.2-121.8	84.9±16.4	15	23.4	36	56.3	13	20.3
FEV_1/FVC (FEV_1%)	51.5-120.0	83.8±10.5	14	21.9	31	48.4	19	29.7
PEF	25.3-113.1	55.9±18.7	44	68.8	15	23.4	5	7.8
MMEF	19.5-147.8	80.1±27.4	33	51.6	22	34.3	9	14.1
FEF_{25}	18.9-127.0	64.5±23.0	24	37.5	37	57.8	3	4.7
FEF_{50}	18.2-126.5	85.2±19.3	30	46.9	26	40.6	8	12.5
FEF_{75}	21.9-171.0	89.1±32.1	32	50.0	23	35.9	9	14.1
MVV	19.6-110.7	52.7±19.5	47	73.4	13	20.3	4	6.3
Plain chest X-ray findings	**No.**	**%**						
Opacities								
Absent	40	62.5						
Present	24	37.5						
Hilar lymph nodes								
Normal	18	28.1						
Enlarged	30	46.9						
Enlarged with calcification	16	25.0						
Honey comb appearance of lung								
Absent	62	96.9						
Present	2	3.1						

Lung function testing revealed a normal pattern among (48.4%) of the workers, a restrictive pattern among (23.4%) of workers, and an obstructive pattern among (21.9%), obstructive restrictive pattern (6.3%), (Figure 2)

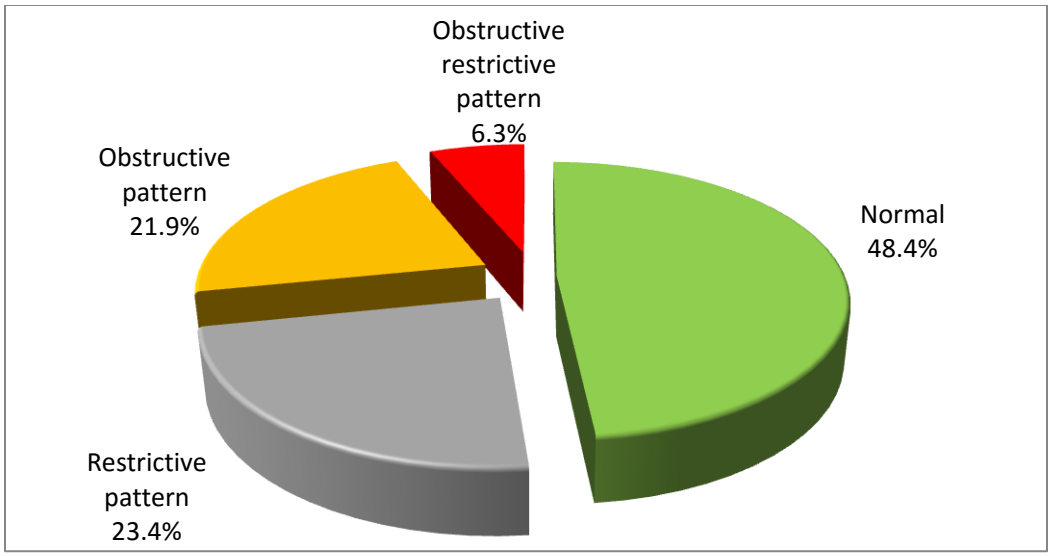
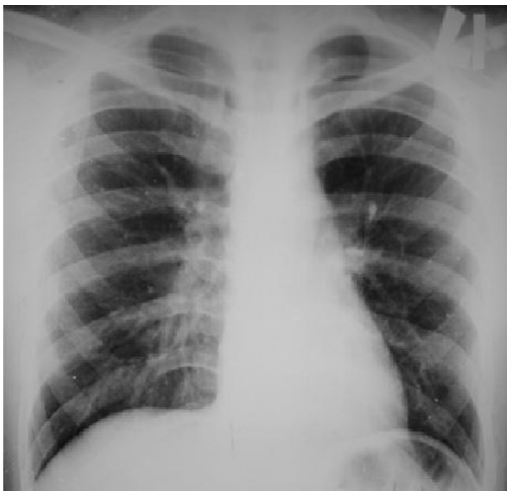
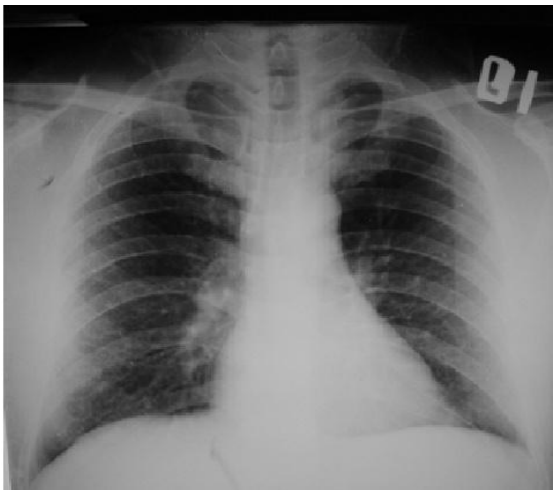


Figure (2): Distribution of lung function testing pattern among the studied workers exposed to silica dust

Plain chest X-ray findings according to ILO classification among silica-exposed workers; (Figure 3-5)

Lung opacities were detected in more than one third of chest radiographs of the studied workers (37.5%) with profusion of (0/1) among (83.3%) and (2/3) among (16.7%) of positive radiographs. Most of the positive radiographs (79.2%) demonstrated nodules of size p/p while the remaining (20.8%) had nodules of size p/q. Extent of the opacities among (45.8%) of the positive radiographs was limited only to upper zone of right lung. While (54.2%) had opacities in more than one zone of the lung; involving upper and middle zones (14%) and all lung zones (40.2%); (Figure 5).





Figure(3): Photo of plain chest X-ray PA view of a silica exposed worker showing lung opacities of shape and size (p/q) and profusion (0/1) involving upper and middle zones of right lung.	**Figure(4): Photo of plain chest x-ray PA view of a silica exposed worker showing lung opacities of shape and size (p/q) and profusion (2/3) involving all lung zones, enlarged hilar lymph nodes.**
Coding of radiographic abnormalities using ILO classification according to **shape**: 'p', 'q' and 'r' are rounded regular opacities, 's', 't' and 'u' are irregular opacities. According to **size**: 'p' and 's' are nodules having size <1.5 mm, 'q' and 't' are nodules having size of 1.5-3 mm , 'r' and 'u' are nodules having size >3-10mm. According to **profusion**: category 0: small opacity is either absent or less profuse than category 1. Category 1, 2, 3: increase profusion of small opacity.	

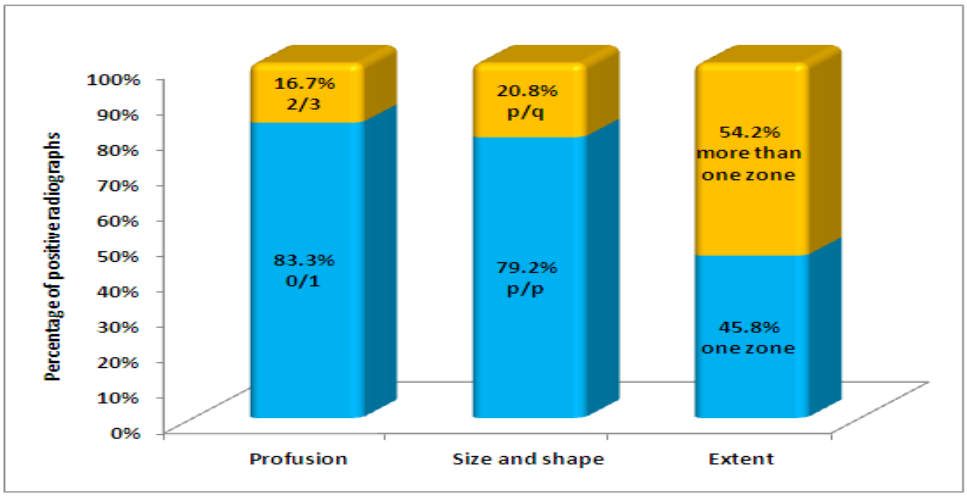


Figure (5): Characteristics of lung opacities among silica-exposed workers showing opacities

Enlarged hilar lymph nodes were evident among (71.9%) of radiographs. Meanwhile, calcification was observed in association with the enlarged lymph nodes among (25%) of workers. Only two workers (3.1%) showed honey comb appearance of the lung. (Table 2)

Serum level of IL-1α:

Serum IL-1α levels were recorded among both silica-exposed workers and a control group of healthy males matched for age (33.1±5.2 years, 33.8±6.4 years respectively); (t=0.67, P=0.698). IL-1α measured among silica exposed workers ranged from 1.9 to 10 pg/ml, with a mean of 2.9±1.7 pg/ml. Meanwhile, IL-1α was not detected in the serum of any of the control subjects. Difference observed between both groups was statistically significant (P<0.0001); (Table 3)

Table (3): Serum level of Interleukin-1α (IL-1α) among silica-exposed workers and their control group

	Silica-exposed workers (n=64)		Control group (n=60)		Significance
Serum level of Interleukin-1α (pg/ml)	**No.**	**%**	**No.**	**%**	
Detected	64	100.0	0	0.0	^{Y}P<0.0001*
Undetected	0	0.0	60	100.0	
Min-Max	1.9-10.0		-		
Trimmed Mean±SD	2.9±1.7		-		

***Significant at P≤ 0.05** **^{Y}P: Yates corrected Chi-Square test**

Relation between serum IL-1α and different characteristics among silica exposed workers:

Correlation between IL-1α and different studied characteristics of silica exposed workers was investigated. It was shown that neither age nor duration of exposure to silica was correlated with IL-1α.

Forced vital capacity in litres (L) **FEV_1:** Forced expiratory volume at one second in litres (L) **MMEF:** Maximum mid-expiratory flow (L/S) **PEF:** Peak expiratory flow rate (L/S) **MVV:** Maximum voluntary ventilation (L/min) **FEF:** Forced expiratory flow (L/S)

Among clinical manifestations, only wheezes was positively correlated with increase of serum level of IL-1α (r=0.494), (Table 4)

Regarding pulmonary function testing, serum IL-1 α was negatively correlated with FVC (r=-0.25), FEV1(r=-0.40), MMEF (r=-0.32), and $FEF_{50\%}$; (r=-0.33). (Table 4)

Considering radiological findings, a positive correlation was detected between the serum level of IL-1α and extent of nodular opacities in lung zones; (r=0.367).Additionally, serum level of IL-1α was positively correlated with presence of both enlarged and calcified hilar lymph nodes; (r=0.337, 0.726 respectively). (Table 4)

Table (4): Correlation between serum level of Interleukin-1 α (IL-1α) and different characteristics of silica-exposed workers

Variables	Serum IL-1α r (p)
Personal characteristics	
Age (years)	-0.16 (0.206)
Occupational characteristics	
Duration of exposure to silica (years)	-0.009 (0.206)
Respiratory manifestations	
Cough (No, yes)	-0.041 (0.864)
Wheezes (No, yes)	**0.494 (<0.0001)***
Dyspnea (No, yes)	0.234 (0.487)
Pulmonary function testing	
FVC	**-0.248 (0.048)***
FEV1	**-0.401 (0.001)***
FEV1/FVC (FEV1%)	-0.051 (0.689)
PEF	-0.212 (0.093)
MMEF	**-0.325 (0.009)***
FEF25	-0.286 (0.532)
FEF50	**-0.334 (0.008)***
FEF75	-0.129 (0.398)
MVV	-0.162 (0.201)
Radiological findings	
Opacities	
Presence of opacities(No,Yes)	0.175 (0.469)
Profusion	0.025 (0.863)
Extent	**0.367 (0.046)***
Size	0.071 (0.769)
Hilar lymph nodes	
Enlargement *(No, Yes)*	**0.337 (0.002)***
Calcification *(no, yes)*	**0.726 (<0.0001)***

r: Spearman's Rho correlation coefficient *significant at p ≤ 0.05

Moreover, table (5) shows that workers with hilar lymph node enlargement had significantly higher level of serum IL-1α (3.1±2.0 pg/ml) compared to workers with normal hilar lymph nodes (2.1±0.2 pg/ml); (P=0.003).Meanwhile, comparing level of serum IL-1α among workers according to presence of nodular opacities revealed absence of such significant difference; (P=0.316)

Table (5): Serum level of IL-1α among silica exposed workers according findings of chest radiographs

Radiologic findings	(n)	Serum level of IL-1α (pg/ml)		Significance
		Min-Max	Trimmed Mean±SD	
Silicotic nodules				
Absent	40	1.9-8.0	2.7±1.7	Z=1.002
Present	24	2.0-10.0	2.9±2.1	P=0.316
Hilar LN				
Normal	18	1.9-2.6	2.1±0.2	**Z=2.994**
Enlarged	44	2.0-10.0	3.1±2.0	**P=0.003***

***Significant at P≤ 0.05** **Z: Mann Whitney test**

ROC curve was used to estimate cutoff point of serum IL-1α that indicates hilar lymph node enlargement; (Figure 6). A level of (2.7 pg/ml) was the cutoff point at sensitivity of 70.8% and specificity of 95.5%.

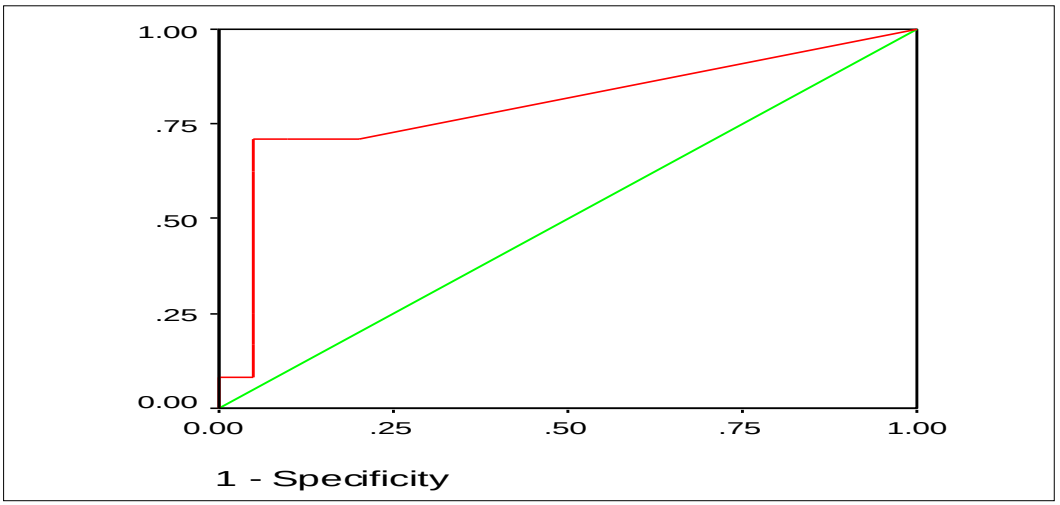


Figure (6): ROC curve for diagnosis of silicosis using serum level of IL-1α
Area under curve =0.794, cutoff point=2.7 sensitivity=70.8%, specificity=95.5%

DISCUSSION

Respiratory manifestations encountered among silica-exposed workers

Silica exposed workers suffered frequently from respiratory manifestations in the form of cough, wheezes, chest pain and varying degrees of dyspnea. Similar findings were recorded in previous studies conducted by Lee et al (2001) [12], Suhr et al (2003) [13] and Hoz et al (2004)[14].

Still, individual susceptibility in the form of polymorphism of enzymes and other molecules may play role in determining extent of respiratory manifestations [15, 16]

Pulmonary function testing using spirometry among silica-exposed workers

Maximum voluntary ventilation (MVV) showed reduction among workers reflecting respiratory impairment. Moreover, the predicted values of (PEF) and ($FEF_{25\%}$) were reduced indicating large airway obstruction that can be attributed to the irritant effect induced by silica dust exposure among the studied workers. These findings were consistent with the study conducted by Suhr et al (2003)[13] as well as Tiwari et al (2005)[17]who explained such obstructive changes by presence of mucosal hypertrophy and mucosal plug formation due to irritation of upper airways by the inhaled silica.

Furthermore, a picture of small airway obstruction was also observed among nearly half of the workers in the form of reduced MMEF, $FEF_{50\%}$ and $FEF_{75\%}$. This might occur either as part of the inflammatory process or due to impaction of the small silica particles in the bifurcation of the small bronchioles. [18]

Also, Ratio of FEV_1/FVC% was declined in almost a quarter of the studied workers as a consequence of reduction of both FEV_1 and FVC. Such result is a feature of mixed obstructive restrictive pattern.

Such lung function results were in agreement with earlier researches

indicating that interpretation of the pulmonary function testing in silica-exposed workers can be complicated as it could result in obstructive, restrictive or combined pattern of pulmonary impairment.[13, 14, 19, 20]

Plain chest X-ray findings according to ILO classification among silica-exposed workers

Presence of nodular opacities in chest radiographs was observed among (37.5%) of the studied silica-exposed workers which is in accordance to an earlier Egyptian study that reported prevalence of silicosis ranging between 18.5% to 45.8%.[3] Chest radiography revealed that the upper zone of the right lung was involved in all the affected workers either alone in 45.8% or together with other lung zones in the rest of the workers. The right upper lung zone was also the main site affected in other studies. [14, 16]

The involvement of the right upper zones represents the standard picture of silicosis, where masses are usually located in the posterior regions of the upper lobes. This might be attributable to the relatively poor lymphatic drainage of this part of the lung.[21]

Almost three quarters of the workers had enlarged lymph nodes with some of them showing calcification as well. Other studies also reported hilar lymphadenopathy and calcification due to silica dust exposure. [16, 20]

Hilar lymphadenopathy could be explained by the fact that much of the inhaled dust is transported to the hilar lymph nodes via lymphatics[22]. Kitamura et al (2007)conducted a study that showed high accumulation of inhaled silica particles in the pulmonary hilar lymph nodes.[22]

Calcification of lymph nodes has been shown to be a direct effect of exposure to silica particles. Brown et al (2007)[23] as well as Tian et al (2010)[24] hypothesized that quartz particles increase intracellular calcium (Ca2+) by increasing permeability of plasma membrane inducing influx of Ca2+ from extracellular compartment through opening

Ca2+ channels in plasma membrane. An increased Ca2+ concentration in cytoplasm causes Ca2+ influx into mitochondria and nucleus, mediating several mechanisms of toxicity leading eventually to cell damage.

Serum level of interleukin-1 α among silica-exposed workers

The present study was concerned with measuring serum level of IL-1α among silica-exposed workers as well as the control group. Serum IL-1α was undetected among the control group while all silica exposed workers showed a detectable level of IL-1α (2.9±1.7 pg/ml).

Inability to detect IL-1α among control group was consistent with results of earlier studies [25, 26] which was explained by the fact that IL-l α in healthy individuals is mostly membrane bound.[27]

Relation between serum IL-1α and different characteristics among silica exposed workers:

A positive correlation was detected between serum level of IL-1α and occurrence of wheezes. Moreover, a negative correlation was also recorded between serum IL-1α and FEV_1, MMEF, FVC, and $FEF_{50\%}$on pulmonary function testing.

Association of increased IL-1α among workers exposed to silica dust emphasizes on the role of IL-1α as pro-inflammatory mediator. Production of IL-1α in response to inhalation of silica further activate additional inflammatory pathways, enzymes and a spectrum of changes leading to neutrophils activation, stimulation of eicosanoid synthesis, gene transcription, as well as induction of cell adhesion molecules. It also stimulates release of several chemical mediators and induces additional cytokine production by other tissue cells, including IL-6, IL-8 and colony stimulating factors.[28]

Such cascade facilitates the accumulation of fibroblasts and fibroblast products inducing inflammatory and fibrogenic reactions in the interstitium and alveoli. Thus IL-1α plays a significant role in the fibrogenic process. Increased production of IL-1α increases the

degree of fibrosis and bronchiolar obstruction leading to progression of wheezes and declining of FEV_1.[29]

The fibrotic role of IL-1α in silicosis was further confirmed by the positive correlation to the extent of radiological opacities in the studied workers. Such findings suggest the usefulness of IL-1α as a prognostic parameter for the progression of silicotic opacities.

Additionally, IL-1α was positively correlated with presence of enlarged calcified hilar lymph nodes among exposed workers regardless presence of lung opacities.

Lee and Richards (2004)[30] reported that lymph node affection preceded the appearance of opacities among silica exposed workers. Moreover, hilar lymphadenopathy caused by inhalation of silica had a role in accelerating development of silicosis on further exposure to silica dust due to impairment of lymph nodes clearance.[30]

CONCLUSION

Correlation between serum IL-1α and lymph node affection may point to its diagnostic value among silica-exposed workers even before the appearance of radiological opacities provided that confounding factors that may lead to its increased production are excluded. This is of great value; since silicosis is a progressive disease, thus use of an investigative parameter that could be detected before appearance of frank silicotic opacities on chest radiography is very beneficial thus allowing for early diagnosis of disease and prevention of its further progression.

Serum IL-1α had neither correlation nor significant statistical difference in relation to presence of pulmonary nodular opacities. Such finding indicates that appearance of nodular opacities had no role on increase level of IL-1α but only extent of the nodular involvement as an indicator for severity of the inflammatory reaction.

RECOMMENDATIONS

Special attention is needed to reduce

incidence of silicosis by implementing strict control measures to limit the risk of silica exposure to the minimum. Moreover, workers should be encouraged and trained to wear personal protective equipment.

Measurement of serum IL-1α can be beneficial for monitoring of cases of silica exposure, provided that other factors leading to its increased production are excluded.

Moreover, further work is recommended on the prognostic role of IL-1α in cases of silica exposure and on other biochemical detectors that can be beneficial for early diagnosis of silicosis.

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