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International Journal of Current Research
Vol. 8, Issue, 11, pp.42412-42417, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

SILICOSIS AND SILICOTUBERCULOSIS IN MINE WORKERS IN NAGAUR, AJMER AND BHILWARA DISTRICT IN RAJASTHAN

Reena Mathur, *Jagmohan, Amit Kumar Sharma, Kapil Meena and Unmila, T. N.

Department of Chest & TB, J. L. N. Medical Collage & Hospital, Ajmer, Rajasthan

ARTICLE INFO

Article History:
Received 15th August, 2016
Received in revised form
30th September, 2016
Accepted 16th October, 2016
Published online 30th November, 2016

Key words:

Silicosis,
Silicotuberculosis,
Crystalline silica dust.

ABSTRACT

Aims and Objectives: To evaluate the chest radiographs of patients having history of crystalline silica dust exposure while working in mines and further to evaluate these findings with respect to the duration of exposure to silica dust and finding correlation between the two.

Materials and Methods: Data for the study was collected from 258 patients having crystalline silica dust exposure while working in the mines in Nagaur, Ajmer and Bhilwara districts of Rajasthan, who presented to J.L.N. Medical Collage, Ajmer with respiratory complaints. A cross-sectional study was conducted for a period from June 2015 to Dec 2015. Chest radiographs of these patients were evaluated by an experienced radiologist in accordance with International Labour Organisation (ILO) classification. These chest radiograph findings were evaluated and studied for their correlation with the duration of silica dust exposure.

Results: In the present study, out of total 258 patients, 60 were having silicosis and 99 were having silicotuberculosis. The most common finding was multiple nodular shadows in116 patients. This study shows increasing trends in number and percentage of patients of silicosis and silicotuberculosis with increase in the number of years of exposure.Data obtained in the study was statistically analysed andp-value after applying ANOVA test was found to be < 0.01 which is statistically significant and proves that there is strong positive correlation between the disease and duration of exposure.

Conclusion: As we can make out from this study that almost 2 out of 3 patient (61.7%) are suffering from either silicosis or silicotuberculosis, so there is need to make more awareness about safety measuresto decrease occupational exposure. There should be regular health check-ups and educational programmes for mine workers. Any respiratory symptom should be taken care immediately.

Citation: Reena Mathur, Jagmohan, Amit Kumar Sharma, Kapil Meena and Unmila, T. N. 2016. "Silicosis and silicotuberculosis in mine workers in nagaur, ajmer and bhilwara district in Rajasthan", *International Journal of Current Research*, 8, (11), 42412-42417.

INTRODUCTION

The word silicosis originates from the Greek word silex, which means flint. It is perhaps the oldest known occupational disease. Pliny and Hippocrates had referred to this disease. (Sherson, 2002) Silicosis remains a major occupational health problem in India. It is still responsible for high mortality and morbidity in industrial workers. (Silicosis – an uncommonly diagnosed common occupational disease, 1999) Silicosis is one of the forms of pneumoconiosis. It is caused by inhalation of crystalline silica particles of 0.5 to 5 microns size in diameter. (Chopra *et al*., 2012) The principal sources of silica exposure are free silica in quarrying, mining, tunnelling, polishing, stonecutting, cleaning monumental masonry, sandblasting, glass manufacturing, pottery and porcelain manufacturing, in foundry work, brick lining, vitreous enamelling and boiler scaling. Coal miners are also exposed to dusts which contain a mixture of mica, coal, kaolin, and silica in different proportion. (Kim *et al*., 2011) Silicosis is an irreversible, potentially fatal, fibrotic lung disease with has a long latent period and may present as acute, chronic or accelerated disease. The pathophysiology of silicosis involves chronic accumulation of various fibrogenicand inflammatory mediators. The rate of progression of the disease depends upon the total amount of silica actually retained in the lungs and rate of deposition. Silicosis has been found to be associated with the concomitant development of some other diseases such as tuberculosis, autoimmune diseases and cancer. (Greenberg *et al*., 2007) As silica dust is odourless and non-irritant, even after the large amount of silica exposure, patients can be asymptomatic. (Sharma *et al*., 2016) For diagnosing silicosis chest radiograph is the most important tool. There appears a direct relationship between the severity of chest radiographic changes and degree of silica exposure. In initial stages, there is reticulation of the lung fields. Howeverdiagnosis of silicosis can be made after the appearance of nodules. Initially the nodules are homogenous in density, 2-5 mm in the diameter and bilaterally symmetrical involving predominantly middle and upper zones

Corresponding author: Jagmohan,
Department of Chest & TB, J. L. N. Medical Collage & Hospital, Ajmer, Rajasthan.

of the lungs. Silicotic nodules tend to increase in size even after cessation of silica dust exposure and sometimes nodules may show calcification. Presence of eggshell calcification of hilar lymph nodes is almost pathognomonic. In later stage, the nodules frequently conglomerate to form the larger shadows known as Progressive Massive Fibrosis (PMF). Still later on these shadows form a contracted dense fibrotic mass which is often surrounded by bullae. Extensive pulmonary fibrosis is invariably seen near the PMF lesions. Cavitation may be seen with or without concomitant tuberculosis. (National institute of Miners Health, Nagpur (2011)) Silicotuberculosis, a disease caused by concomitant infection with tuberculosis in a patient of silicosis. Prolonged exposure to silica dust increases risk of tuberculosis infection and aggravation of pre-existing pulmonary tuberculosis. Tuberculosis sometimes may go unnoticed in silicosis patient because of vague and almost same clinical symptoms. Interpretation of chest radiographs may be difficult due to superimposition of tuberculous infiltrates and silicotic nodules. (Sharma *et al*., 2016)

Though mining in India was practiced much earlier than in Europe, the first cases of silicosis were described by Caplan and Burden in gold miner in Kolar gold mines in 1940s.[8] There are a few epidemiological studies in India on silicosis and almost all of them are cross sectional in nature. These studies show silicosis prevalence from 3.5% in ordnance factory to as high as 54.6% in slate pencil industry. As most of these values are based on cross sectional studies, many cases may be missed due to death or sickness at the time of survey and due to working in unorganised sector, the estimates might not reflect the actual burden of the disease. (Silicosis – an uncommonly diagnosed common occupational disease, 1999)

Aims and objectives:

1. Evaluation of chest radiographs of the patients with history of occupational crystalline silica dust exposure.
2. Correlationof chest radiographs findings with duration of crystalline silica dust exposure.

MATERIALS AND METHODS

1.Source of data

A total of 258 patients, working inmines in Ajmer, Bhilwaraand Nagaurdistricts of Rajasthan were evaluated in the department of radiodiagnosis, JLN hospital, Ajmer.

2.Duration of study

This study was conducted from june2015 to dec2015.

3.Study design

A cross sectional study design was chosen.

4.Method of study

Chest radiographs of 258 patients with history of occupational exposure to crystalline silica dust were evaluated. The diagnosis of silicosis and silicotuberculosis were made on the basis of chest radiograph findings by an experienced radiologist in accordance with ILO classification with an unequivocal history of occupational crystalline silica exposure in past.

5. Inclusion criteria

- History of occupational crystalline silica dust exposure in past.
- Age above 18 years.

6. Exclusion criteria

- History of exposure to any other pneumoconiosis agent.
- History of tuberculosis or any other significant pulmonary illness in past before the starting of crystalline silica exposure.
- History of any autoimmune disease.

RESULTS

Age distribution:

Table 1. Age distribution of patients studied

Age (years)	No of patients	Percentage (%)
<30	21	8.1
31-40	54	20.9
41-50	93	36.0
51-60	68	26.4
>60	22	8.5

Sex distribution:

Table 2. sex distribution of patients studied

Sex	No of patients	Percentage (%)
Male	245	95
Female	13	5

District wise distribution:

Table 3. District wise distribution of patients studied

District	Number of patients	Percentage (%)
Nagaur	142	55.0
Ajmer	59	22.9
Bhilwara	57	22.1

Frequency of chest radiograph findings:

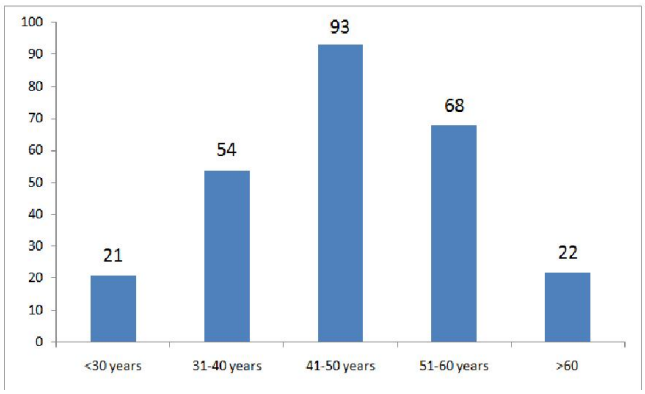
Table 4. Findings of chest radiographs of patients studied

Chest radiograph finding	Number of patients
Multiple nodular shadows	116
Cavitary lesions	36
Fibrosis	20
Eggshell calcifications	13
Fibrocavitary lesions	12
Pleural effusion	6
Pneumothorax	3
Progressive massive fibrosis (PMF)	2

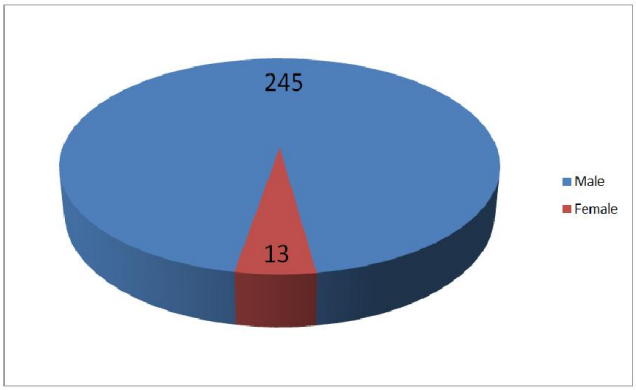
Frequency of silicosis and silicotuberculosis with respect to number of years of exposure:

Table 5. Chest radiograph findings of Silicosis and Silicotuberculosis according to number of years of exposure

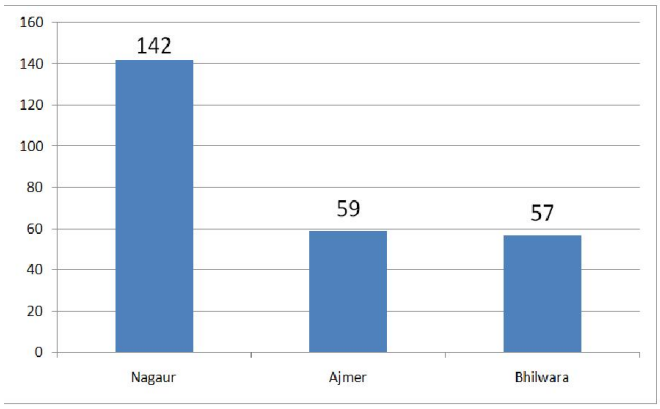
No of years of exposure	Total subjects	Silicosis	Silicotuberculosis	Total
0-5 years	16	2(12.5%)	5(31.2%)	7(43.7%)
5-10 years	33	6(18.2%)	11(33.3%)	17(51.5%)
10-15 years	41	9(21.9%)	14(34.1%)	23 (56.1%)
15-20 years	44	10(23.3%)	17(38.6%)	27(61.2%)
>20 years	124	33(27.0%)	52(41.9%)	85(68.5%)
Total	258	60(23.3%)	99(38.4%)	159(61.6%)



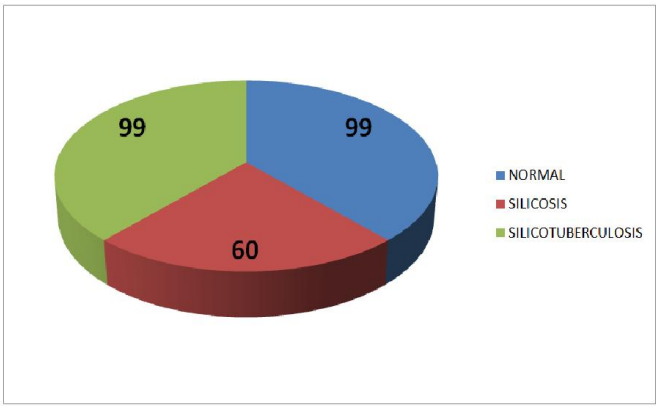
Graph 1: Age distribution



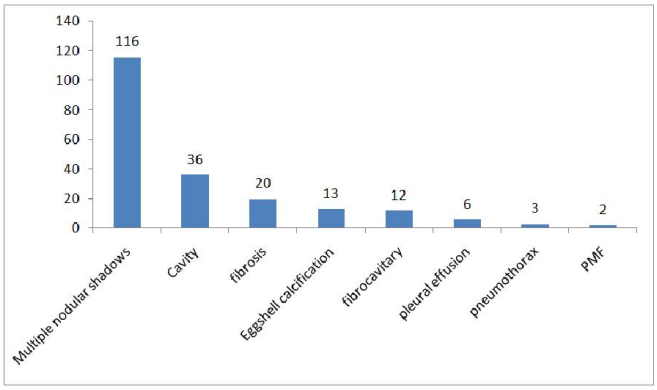
Graph 2: Sex distribution



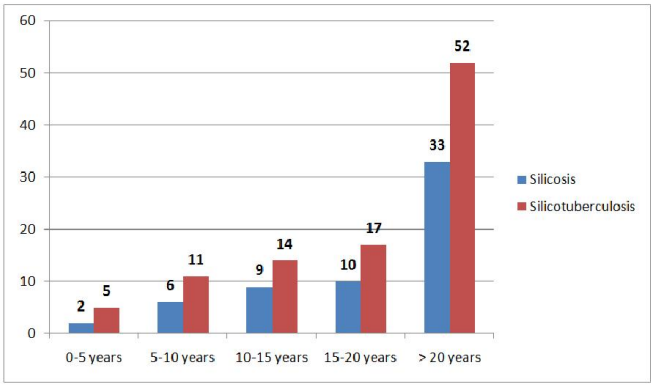
Graph 3: District wise distribution



Graph 4: Chest radiograph findings



Graph 5: Various lesions on chest radiographs plotted according to frequency of lesion



Graph 6: Number of patients of silicosis and silicotuberculosis according to number of years of exposure

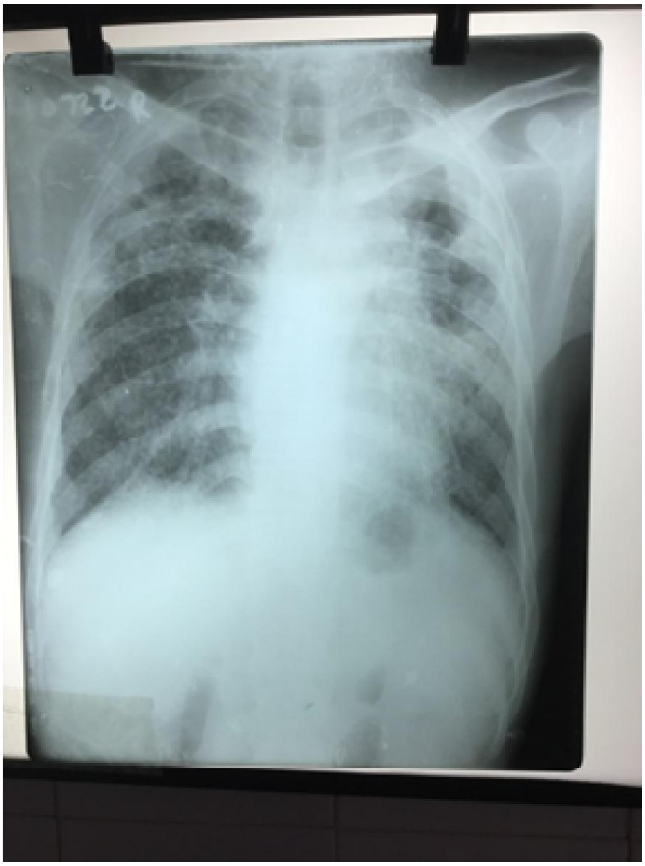


Image 1. Multiple nodular shadows in B/L lung fields

Image 2: Egg-shell calcifications in B/L hilar region with patchy opacities in B/L lower lung fields

Image 3: Cavitary lesion in right upper zone with ipsilateral mediastinal shift and volume loss with reticulonodularopacities in left lung field

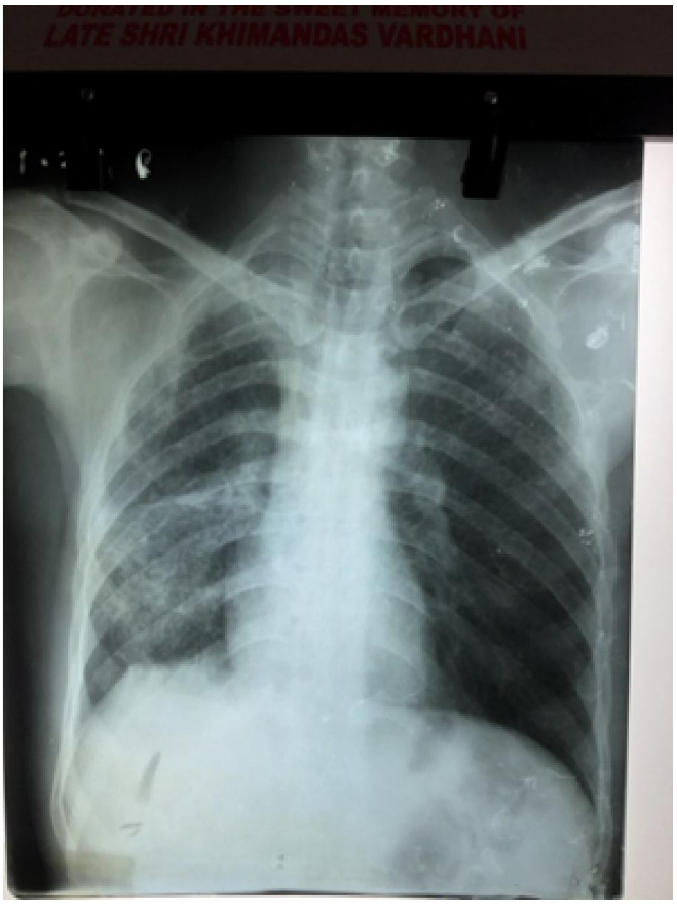


Image 4: B/L fibrotic bands with tenting of right dome of diaphragm with B/L multiple nodular shadows

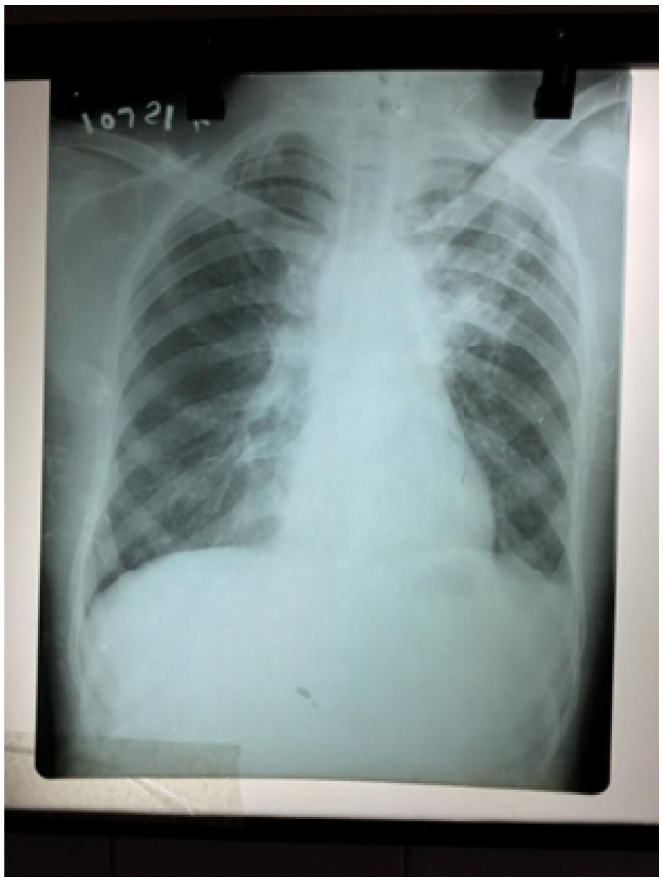


Image 5: Left pleural effusion with fibrotic bands in left upper zone with B/L multiple nodular shadows

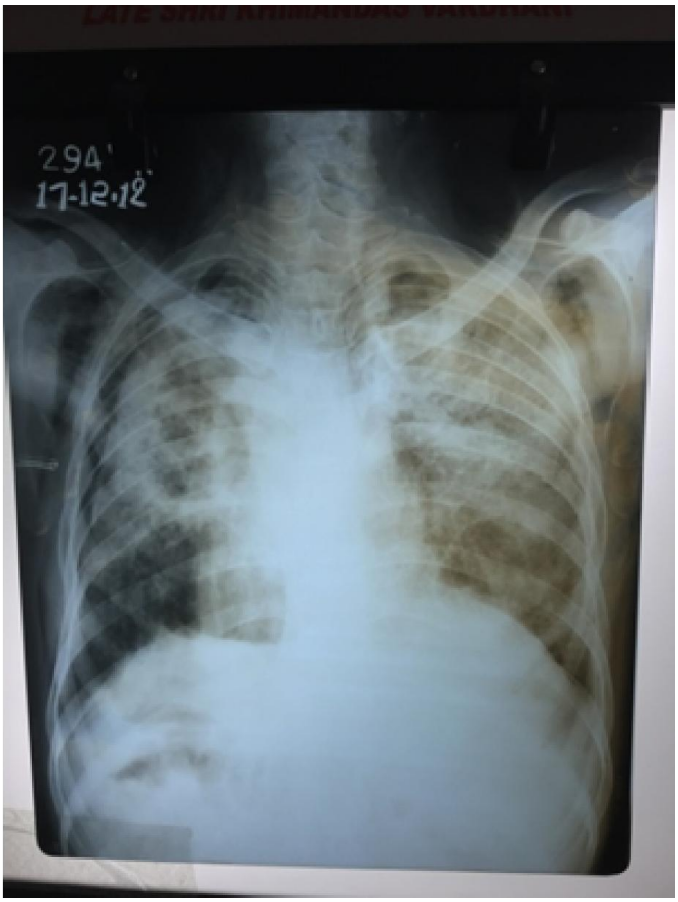


Image 6: Pneumothorax with tenting of diaphragm with cavitary lesion on right side with B/L multiple nodular shadows

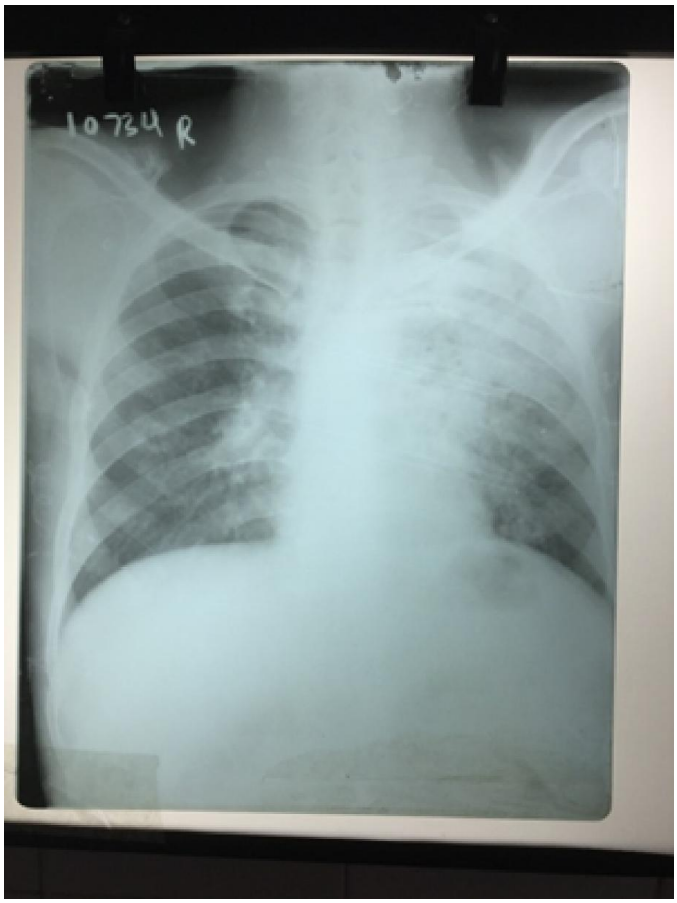


Image 7: Conglomerated patchy opacities (PMF) in left lung field with B/L multiple nodular shadows

OBSERVATIONS AND DISCUSSION

The study was conducted in department of radiodiagnosis, JLN medical collage, Ajmer, Rajasthan from June 2015 to December 2015(6 months). Total 258 patients working in mines in Ajmer, Bhilwara and Nagaur districts in Rajasthan were evaluated. The patients were having respiratory complaints such as cough, shortness of breath, expectoration, chest pain, fever etc. These patients were evaluated on the basis of chest radiographs (PA view) by an experienced radiologist in accordance with ILO classification of radiographs of pneumoconiosis. (ILO, 2011) Chest radiographs were evaluated for the findings of silicosis, silicotuberculosis and its other complications. The radiological findings and related dataare described in following sections. In the present study, an attempt had been made to evaluate the radiological findings and their correlation with the duration of exposure of causative agent.The duration of exposure in our study varies from a minimum of 6 months to a maximum of 50 years. Maximum number of patient (n=124) were having an exposure for more than 20 years. Mean duration of exposure in the study sample was 19.74 years. A higher mean duration of exposure of 28.74 years was reported by Chopra *et al*. (2012) in their study on silicotuberculosis in western Rajasthan in 2011 but maximum number of patients had a duration of exposure of 16-20 years which is similar to our study. Sishodiya *et al*. (http://aravali.org.in/themes/upload/files/276725.pdf, http:// www.indianet.nl/pdf/DetectionOfSilicosisAmongStoneMineWorkersFromKarauliDistrict-Report-II.pdf) also reported maximum number of cases with silicosis after 11-20 years of working in stone mines in Karauli district in Rajasthan in their studies in 2011 and 2014. This can be explained on the basis that the usual latent period for developing silicosis is 15-20 years. It was a male predominant study as 95% (n=245) out of total 258 patients were male. Rest 5% (n=13) were female. Similar observations showing very few females were found in studies done by Sishodiya (http://aravali.org.in/themes/upload/ files/276725.pdf, http:// www.indianet.nl/pdf/Detection Of Silicosis AmongStoneMineWorkersFromKarauliDistrict-Report-II.pdf) *et al* in Karauli district in 2011 and 2014. This could be attributed to the predominance of male workers in mines. The age of patients studied was having a range from minimum age of 22 years to maximum age of 72 years.Mean age of study sample was 47.3 years. Maximum 36% (n=93) of patients were between 41–50 years. Similar observations were made by Sishodiya *et al*. in 2011 and Chopra *et al*. in 2012 in their studies who reported 38.6% and 31.9% respectively in 41-50 years age group. This is the most productive age group in our country therefore most of the patients were falling in this age group. Out of 258 patients, maximum number of 142 (55.0%) patients were from Nagaur, 59 (22.9%) from Ajmer and 57 (21.1%) from Bhilwara district. The radiological findings in the studied chest radiographs weremultiple nodular shadows, cavitary andfibrocavitary lesions, eggshell calcifications, fibrosis, pleural effusion, pneumothorax and progressive massive fibrosis (PMF). Most common finding was multiple nodular shadows noted in 43.79% (n=113) patients which is the most typical finding seen in silicosis. Second most common finding was cavitary lesions in 36 patients. Other findings in decreasing order were fibrosis (20), eggshell calcifications (13), fibrocavitary lesions (12), pleural effusion (6), pneumothorax (3) and PMF(2).Out of total 60 chest radiographs showing evidences of silicosis, 3.3% (n=2) developed large opacities suggestive of PMF.

In the present study, out of 258 patient studied 23.3% (n=60) were having silicosis and 38.4% (n=99) were having silicotuberculosis. Total of 61.6% (n=159) patients were having either silicosis or silicotuberculosis. Chest radiographs of remaining 38.4% (n=99) patients were unremarkable. Comparable results showing prevalence of 22% of silicosis and 48% of silicotuberculosis were found in Latipur district in U.P. by Kashyap in 1994 in stone cutters.A higher prevalence of 45.6% of silicotuberculosis was reported by Chopra *et al*. in 2012 from western Rajasthan. Sikand and Pamra in 1949 recorded 52.4% prevalence of silicosis in stone cutters and 12.5% in stone breakers. Sishodiiya *et al*. (http://aravali.org.in/themes/upload/files/276725.pdf, http:// www.indianet.nl/pdf/DetectionOfSilicosisAmongStoneMineWorkersFromKarauliDistrict-Report-II.pdf) reported significant higher prevalence of 78.5% of silicosis in 2011and 50% in 2014 in their studies in Karauli district of Rajasthan. This variation in prevalence rates can be attributed to various factors on which occurrence of silicosis depends such as duration of exposure, chemical composition of silica containing chemical compounds, size of particles, individual susceptibility, preventive measures used, and type of industry in which silica exposure occurs.

Results of the study sample were statistically analysed for studying the relationship between the number of patients suffering from silicosiswith respect to number of years of exposure of silica dust by applyingANOVA test. P-value was found to be < 0.01, which is statistically significant. Thus in this study, it signifies a strong correlation between the disease and the duration of exposure of its causative agent. The present study shows increasing trends in the percentage and number of patients diagnosed as either having silicosis or silicotuberculosis with increase in the number of years of exposure to crystalline silica dust.For silicosis, it increases to 27.0% in patients having exposure of > 20 years as compared to 12.5% in 0-5 yearsexposure group. There is more than two times (2.16 times) increase in the frequency of patients affected with silicosis for an additional >15 years exposure time as compared to 0-5 years group. Out of the total 60 patients diagnosed as having silicosis 55.0% (n=33) were having exposure for > 20 years and only 3.3% (n=2) were in 0-5 exposure group.For silicotuberculosis it increases to 41.9%in patients having exposure of > 20 years as compared to 31.2% in 0-5 years exposure group. There is 1.34 times increase in the frequency of patients affected with silicotuberculosis for anadditional >15 years exposure time as compared to 0-5 years group. Out of the total 99 patients diagnosed as having silicotuberculosis 52.5% (n=52) were having exposure for > 20 years and only 5.0% (n=5) were in 0-5 years exposure group.

Conclusion

Silicosis is still a major occupational health problem of our country even in 21th century. It is affecting a large number of workers, still larger number go unnoticed due to involvement in unorganised sector. There is an urgent need to start comprehensive studies to find out the hidden cases and accurate prevalence. As our study shows a direct correlation between chances of occurrence of silicosis and silicotuberculosis with the duration of exposure, there should be meticulous evaluation of every respiratory complaint in workers especially the worker in their early years of exposure, so that this disease can be diagnosed and taken care at very early stages. All cases must be notified and the immediate treatment and early rehabilitation should be provided to all of them. More effective protective measures should be taken for the worker while working such as wearing face masks, limiting exposure duration per day. Workers, mine owners and local doctors should be educated and made aware of silicosis and its complications. There should be regular health check-ups. On a final note, a little has been done still very much to be done to prevent the workers from the hazardous effects of crystalline silica dust exposure.

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