ORIGINAL RESEARCH PAPER

Pulmonary Medicine

ASSESSMENT OF SYMPTOMS AND PULMONARY FUNCTION AMONG ALUMINIUM FACTORY WORKERS DONE IN A TERITIARY CARE HOSPITAL IN KANCHIPURAM

KEY WORDS: *aluminium, spirometry, DLCO, HRCT*

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ABSTRACT

Background: Aluminium is prevalent and essential alloy in daily life of many people being used in wide variety of aspects and is considered as the second most used metal after steel.

Objectives:

1) To study the respiratory symptoms and lung function of workers in aluminium factory.

2) Radiological assessment of pulmonary manifestations with high resolution Computed Tomography (CT) scan of chest among the workers.

Materials and methods: 40 workers in aluminium factory were included in this study were screened with HRCT chest,SPIROMETRY and DLCO.

Results:70% workers showed normal spirometric values,while 17.5% had mild restriction,2.5% had mild obstruction and 10% had small airway obstruction.5%of group had reduced DLCO.95% workers showed normal HRCT findings while 5% of them were abnormal.

Conclusion:95% of workers were non smokers and usage of personal protective measures were strictly adhered by them,which can be considered as an explanation for predominantly normal lung functions and radiological findings in this study.

Introduction:

Workers at aluminium industries are exposed to various occupational hazardous factors such as fumes and gases, mineral dusts, coal tar pitch volatiles, electromagnetic fields and others[1].Aluminium factory workers have been shown to suffer from respiratory symptoms either chronic or work related ones as cough, phlegm, dyspnoea, wheezing and chest tightness. In the early studies in the aluminium industry,fluorosis was considered the major health outcome[2]but with the reduction in fluoride exposures through effective fume extraction and environmental controls, this is no longer of concern in most modern potrooms. Respiratory diseases such as potroom asthma, have been the main focus of over 50 epidemiological studies since the 1960's[3]. Pulmonary aluminosis or 'aluminium lung' is defined as pneumoconiosis caused by the presence of dust containing aluminium in the lung tissue,although very rare. It is characterized as diffuse interstitial fibrosis which is mainly located in the upper and middle lobes of the lung[4]. In advanced stages it is characterized by subpleural bullous emphysema with an increased risk of spontaneous pneumothorax.The condition is clinically significant in that it may result in pulmonary fibrosis.

Materials & Methods :

A descriptive study was conducted among 40 aluminium factory workers who were referred for screening to the department of respiratory medicine at Meenakshi Medical College and hospital, Kanchipuram in the month of June, 2014. Screening protocol was approved by ethical committee of the medical institute. The workers were from a light alloy manufacturing company in Tamil Nadu. They were involved in manufacturing of wheel cylinder, master cylinder, compressor housing & turbine wheel.They were exposed to chemicals which included- Phenolic resin in organic solvent, Aluminium silicate, Aluminium oxide, Graphite, Sodium Metasilicate, Zirconium silica, Silicate mineral, Silica, Talc, Sodium chloride, Potassium chloride, Sodium Aluminium Fluorine, Sodium silicate, sodium salts & Limestone.

All the workers worked for a minimum of 8 hours per day. Each worker had a specific work type and were grouped under ALUMINIUM HEATING, ALUMINIUM MOULDING, MELTING, SUPERVISOR/QUALITY ASSURANCE, METAL POURING, DYE, SAND BLASTING, CUTTING and as OPERATOR. Few of them came under combined work type.Protective measures and gears during working hours were used by all of the workers like face mask, Goggles, Ear plug, Ear muff, Apron, Hand leaves, Shoes, Safety helmet, Face shield, Hand gloves (PVC, Cotton), Leg Guard etc.

Age, sex, height and weight, smoking status, total years of experience in the same occupation and the no. of working hours per day were noted.A detailed questionnaire including clinical symptoms like cough, breathlessness, wheeze, sneezing and running nose, type of work, years of exposure was taken for every individual. Body mass index (BMI) was calculated using the standard formula i.e weight in kilograms divided by the square of the height in metres (kg/m^2), as per WHO BMI Guidelines[5]. Past history of diabetes, hypertension and prior respiratory illness including tuberculosis were recorded. General physical examination and detailed respiratory system examination was carried out in all the subjects.

Assessment of lung function was performed in all the study subjects by a trained medical technician using a calibrated portable spirometer 'KOKO LEGEND' model and DLCO machine 'EasyOne pro' model. The FVC,FEV_1,FEV_1/FVC,FEF_{25-75} and PEFR were obtained by spirometer.DLCO values along with predicted percentage were taken. The procedures were performed as per the acceptability and repeatability criteria described in ATS 2005 guidelines[6]. A high resolution computed tomography scan of thorax was done for all the subjects and the detailed radiographic findings were noted and final report was provided by the senior radiologist.

Statistical analysis :

Statistical analysis was done after the data was collected, and was analysed by SPSS (Statistical Package for the Social Sciences) version 21 IBM.Descriptive statistics were calculated.The results were expressed in terms of frequency distribution and percentages. Mean and standard deviation were obtained for variables.

Results :

Totally 40 subjects were referred for screening and all of them were enrolled in the study after their informed consent. All the subjects were males. Mean age was 41.8 years. Only 5%(n=2) of

the subjects were occasional smokers with 0.75 pack years history. Rest of them(95%,n=38) were non smokerswho never smoked in the past. Out of 40 workers, 85%(n=36) had history of working in the same occupation for a period of minimum 15 years and more. 12.5% of subjects were obese according to their BMI and the rest were between normal to overweight.The details are provided in table 1. The details of work type exposure of the subjects are provided in table 2.

Table 1: Characteristics of aluminium factory workers among study group (n=40)

Characteristics	No.	Percentage(%)
Sex		
Male	40	100
Age years		
Mean ±SD	41.80±2.857	
Smoking status		
Current smoker	2	5
Ex smoker	0	
Non smoker	38	95
Duration of employment		
Mean yrs ± SD	16.63 ± 3.499	
DLCO		
Normal	38	95
Decrease	2	5
HRCT		
Normal	38	95
Abnormal	2	5

Table 2: Type of occupational exposure among the subjects

Worktype	*Frequency(n=40)*
Aluminium heating	3
Silca exposure	0
Aluminium moulding	16
Melting, silica exposure	1
Moulding and melting	1
Moulding and dye	3
Moulding and cutting	1
Melting	7
Supervisor/quality assurance	1
Metal pouring	1
Dye	0
Dye, sand blasting	1
Sand blasting	0
Cutting	1
Operator	4

Symptoms

30% (n=12)workers had symptoms overall, out of which 6 workers complained of cough(3-10days),7 workers had both running nose and sneeze. 2 workers had wheeze associated with running nose and sneeze. One worker had combined symptoms of cough, breathlessness, wheeze,running nose and sneezing. General physical examination and systemic examination was normal. X-ray chest showed no abnormality for all the study subjects.

Spirometry

According to ATS guidelines[6],spirometry was done and values were obtained. Spirometry was normal in 70% (n=28)of study group, where as 17.5% (n=7)showed mild restrictive pattern (FVC obs/FVC pred 60- 80%),10% (n= 4)showed small airway obstruction(FEF 25-75 <80%) followed by 2.5%(n=1) showing mild obstruction (FEV_1/FVC% < 70, FEV_1>80%)*(Table 3)*.

Table 3: Spirometry pattern among the study subjects

Spirometry pattern for the total study subjects(n=40)	
Pattern	**Percentage% (n)**
Normal	70% (28)
Obstructive	
mild	2.5%(1)
Restrictive	
mild	17.5%(7)
Small airway obstruction	10%(4)

Diffusing capacity of the lungs(DLCO)

DLCO of (n=38)95% study subjects were normal (>75% of predicted), whilst (n=2)5% of group showed decreased value. Among subjects with decreased DLCO, one had mild decrease with 74%(mild decrease =60-74%) and the other had moderate decrease of 59%(moderate decrease= 40-59%).Descriptive statistics are provided in *table 4*.

Table 4 : Descriptive statistics of the subjects

Character	Mean	SD
Age	41.80	2.857
Height	165.65	6.179
Weight	74.68	11.364
BMI	27.1855	3.81515
Years of exp	16.63	3.499
Hours/day	8.00	.000
FVC	3.0420	.48945
FVC%	105.18	127.112
FEV1	2.6058	.39769
FEV1%	87.93	9.957
FEV1/FVC	85.083	6.7327
FEF2575	92.88	29.418
PEFR	87.95	18.786
SPIRO	1.75	1.548
DLCO	25.720	4.3986
DLCO%	87.15	13.410

HRCT

High resolution CT imaging of thorax showed normal findings for (n=38) 95% of the study group where as the other 5% which consisted of 2 subjects were showing abnormal findings. The first subject showed few random nodules with surrounding ground glass opacities in the lower lobe of left lung. The second showed few thin fibrotic strands in left lower lobe who also had a prior history of pulmonary tuberculosis and was treated with anti-tubercular therapy.

Discussion:

All the subjects in the study were equipped with protective gears. Measures like face mask, overalls, earplugs or muffs, gloves, gaiters, safety boots, face shields and eye protection greatly reduce the occupational exposure.Most of the cross-sectional and longitudinal studies have shown an increased occurrence of respiratory symptoms in general as well as work-related asthmatic symptoms in aluminium potroom workers compared with controls. A study in Germany by Thomas Kraus et al[7] where 62 subjects working in aluminium factory were evaluated for lung function analysis, HRCT and immunological tests and it was reported that 24%(n=15) workers had chronic cough and phlegm, out of which 11 of them were smokers. In the current study, we had 15%(n=6) out of total study group(n=40) who had cough, out of which none of them were smokers. We can say, although not conclusively, that smoking does manifest as risk factor in increased symptoms in occupational environment.

Epidemiological studies have implicated that exposures like coal tar pitch volatiles, fluorides, alumina, gases such as carbon monoxide and sulphur dioxide act as casual agents for excess cancers and/or respiratory disease in the primary aluminium industry[8,9]. Similarly, in above mentioned study by Thomas Kraus et al[7], 24.2%(n=15) of the study group showed parenchymal changes characterized by small rounded opacities predominantly in the upper lung region. In our study, DLCO and CT scan of the individuals were normal in 95% (n=38) of subjects. Only one subject who had random nodules with surrounding ground glass opacities was corresponded to ILO classification for Pneumoconiosis[10]and was found insignificant.

A case series study conducted among aluminium factory workers by Lamiaa H. Shaabanet al.[1] has revealed that FVC%, FEV1%, FEV1/FVC were significantly lower among exposed workers compared to partially exposed ones to occupational pollutants. In our study, spirometric values showed mild obstructive and

restrictive pattern including small airway obstruction in 30 % (n=12) of study group while the rest 70% (n=28) had absolutely normal values. There were no findings of severe or moderate patterns of both obstruction and restriction. This can be attributed to the use of protective gears at work which significantly reduce the exposure.

In our study, it was notable that only one subject had combined symptoms of cough, breathlessness, wheeze, sneeze and running nose and was suggestive of bronchial asthma. However, his DLCO, spirometry and CT scan were normal. 17.5% (n=7) subjects had symptoms of allergic rhinitis. All the subjects were under non-administrative work type. A cross-sectional study in Australia conducted by Fritschi et al[11]who concluded that rhinitis was the only symptom reported more commonly by the potroom employees compared to administration employees.

Over the last 15 to 20 years, irritant-induced asthma has been acknowledged as a type of occupational asthma[12].Fortunately, the number of workers with potroom asthma seems to have decreased during the last decade,concurrent with a decrease in dust and gas exposure in the plants[13].One of the study supports preventive measures in the working environment of cast-house workers with a focus on peak exposures to irritants[14]. Exposure should be minimised and health surveillance should be offered to exposed workers. The most important preventive measures are to decrease exposure through decreased pollution in the work atmosphere, use of airway protection during the most-exposed work tasks and cessation of smoking. It is important that in addition to a reduction in exposure, specific and efficient measures of secondary prevention are to be implemented.

Our study had a small sample size and it was only a descriptive study. A case control study with a big sample size with comparison of results among exposed and non exposed group would have provided more significant results.

Conclusion:

Both the factory workers as well as the people dwelling in the surrounding community are affected by aluminium associated manufacturing industries. Early detection of pulmonary manifestations can be done by assessing lung function and HRCT screening. The respiratory dangers are significantly more in workers who are exposed to gases and pollutants than those who are unexposed. Smoking can be considered as a risk factor and plays increased role in respiratory manifestations among workers in an aluminium factory. However, the use of personal protective equipments which reduce the exposure to the harmful substances does considerably affect in minimizing the adverse health effects.

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