Indian J Physiol Pharmacol 2003; 47 (3): 337–342

LUNG FUNCTION TESTS IN ELECTROPLATERS OF EAST DELHI

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(Received on April 8, 2002)

Abstract : The presence of high concentration of metals (Cr, Cd, Co, Ni, Pb, etc.) in the work place environments of various types of industries including electroplating units are well known to influence respiratory system. Pulmonary function tests including forced expiratory capacity (FVC), volumes, mechanics and slow vital capacity (SVC) were studied in 80 males, divided into group I and Group II of 40 each were drawn from electroplating and non–electroplating units, respectively from East Delhi factories. The lung function tests were measured using computerized Spiro–232 of P.K. Morgan, Values of majority of lung function parameters such as FEV_1/FVC%, FEF_{50} FEF_{75}, PIFR, FIF_{50}, MVV and SVC were decreased in electroplaters, perhaps due to the exposure to metals and their lower anthropmetric results as compared with non electoplaters. Where as results of TLC, FRC, RV & RV/ TLC% were higher in electroplaters and this may be attributed to higher values of RV in them as compared with non electroplaters.

Key words:

INTRODUCTION

A variety of heavy metals are known to be present in excess of the recommended permissible levels in the industrial air particularly those involved in metal processing as reported in India and abroad (1–7). The metals commonly used during the electroplating processes are Cr, Cd, Co, Ni, and Pb (8). The most common mode of entry of metals into the human body is via inhalation may cause lung diseases in the form of an obstructive, restrictive or combined. There are reports incicating major pathophysiological pulmonary derangements resulting from chronic and high exposure to these metals in the form of asthma, emphysema, pulmonary fibrosis and lung cancer (9–12). However most of the researchers carried out only a few ventilatory lung function tests (FEV_1, MVV and PEFR) along with recording of clinical signs and symptoms in factory workers and correlated their results with work place environment. Hence we attempted an exploratory pulmonary function measurements and

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compared these in electroplaters and non–electroplaters.

METHODS

The study was carried out between June 1999 and January 2000. All the workers included in the study were drawn from the electroplating and non–electroplating units of the metal–ware factories situated in the Jhilmil Industrial Area of East Delhi. The study was conducted in 84 male workers (all smokers) who were 18 to 46 years old. After elimination due to error in the recorded result, 80 workers were included in the study. Further they were divided on the basis of nature of work, into two group of 40 workers each. Group I drawn form the electroplating units and Group II workers were from the non–electroplating units respectively.

A primary screening was done to exclude gross pulmonary and heart diseases not related to occupational hazards (like congenital heart disease, rheumatic heart disease, tuberculosis, etc), central and peripheral nervous system or any other disorder.

Each worker was interviewed using a modified ATS–DLD–78 questionnaire [A respiratory disease questionnaire for use in adults for epidemiological research study recommended by the American Thoracic Society –National Heart and Lung Institute Division of Lung Diseases– 1978] (13).

General physical and systemic examinations were conducted on each of the subject. Anthropometrical measurements were also carried out. Lung functions were measured by Spiro– 232 of P.K. Morgan. Prior to the recording of lung functions, satisfactory demonstrations were made to the subjects. Consequently a minimum of three was taken respiratory manoeuvres of each subject were recorded and best of the three was taken so as to have reproducibility and validity of the recorded parameters. The lung function parameters included are:– FVC (Forced Vital Capacity), $FEV_{0.5}$ (Forced Expiratory Volume in 0.5 secs), FEV_1 (Forced Expiratory Volume in 1 sec), FEV_3 (Forced Expiratory Volume in 3 secs), FEV_1 /FVC% (Ratio of FEV_1 to FVC expressed in percentage), FEF_{25} (Forced Expiratory Flow during 25% of expiration), FEF_{50} (Forced Expiratory Flow during 50% of expiration), FEF_{75} (Forced Expiratory Flow during 75% of expiration), PEFR (Peak Expiratory Flow Rate), PIFR (Peak Inspiratory Flow Rate), FIVC (Forced Inspiratory Vital Capacity), FIF_{50} (Forced Inspiratory Flow during 50% of inspiration), MVV (Maximum Voluntary Ventilation), IC (Inspiratory Capacity), ERV (Expiratory Reserve Volume), FRC (Functional Residual Capacity), RV (Residual Volume), TLC (Total Lung Capacity), RV/ TC% (Ratio of Residual Volume to Lung Capacity), Raw (Airway resistance), Kst (Compliance), SVC (Slow Vital Capacity) and TV (Tidal Volume).

Statistical analysis

The collected data was analysed for mean and standard deviation. Student 't–test' was applied for comparison between the electroplaters and non–electroplaters. Also the results of pulmonary function test correlated with the duration of work and smoking.

RESULTS

Results of anthropometry, work duration and smoking habits are presented in Tables I and II. The lung function results are presented in Table III. The values of FEV_1/FVC%, FEF_{50}, FEF_{75}, $PIFR_{50}$, MVV and SVC appear to be better in no–electroplaters as compared to electroplaters and are statistically significant. Non–electroplaters further depicting improved lung function test as compared to electroplaters (Table–III). The statistical difference in lung function tests between the two groups of workers can also be visualized through bar diagrams (Figs.1 to 4). Considering all the above parameters we find that TLC value is higher in electropaters and this could perhaps be attributed to increased RV values, indicating air trapping in the lungs of electroplaters as compared with non–electropaters (Figs. 1 to 4).

TABLE II: Smoking habits in electroplaters and non-electroplaters.

S. no.	*Variable*	*Eletroplaters Mean ± SD*	*Non-electroplaters Mean ± SD*
1.	Duration of smoking (years)	12.02±7.12	13.23±8.97
2.	Frequency of smoking (no. of bidis per day)	2.90±1.88	3.45±1.86

TABLE I: Anthropometrical variables and work-duration in electroplaters and non-electroplaters.

S. no.	*Variable*	*Eletroplaters Mean ± SD*	*Non-electroplaters Mean ± SD*	*P value (t) test*
1.	Age (years)	27.00±7.06	28.48±9.07	0.0+20
2.	Height (cm)	165.48±6.56	167.72±4.24	0.073
3.	Weight (kg)	51.46±6.74	56.84±6.49	0.001*
4.	Body surface area, BSA (m^2)	1.56±0.10	1.64±0.9	0.001*
5.	Duration of work (years)	6.35±4.96	4.29±3.38	0+36

*Significant P<0.001

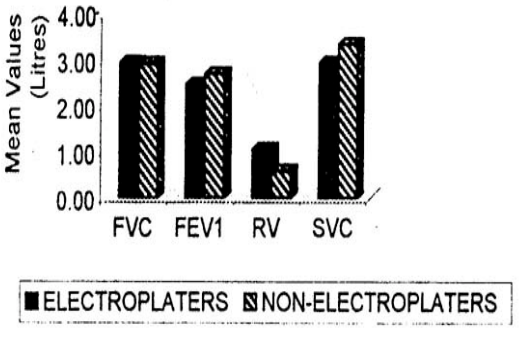

Fig. 1

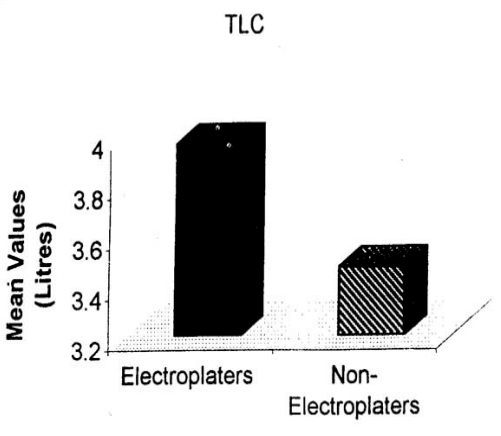

Fig. 2

TABLE I: Pulmonary function test results in electroplaters and non-electroplaters.

S. no.	*Variable*	*Eletroplaters Mean ± SD*	*Non-electroplaters Mean ± SD*	*P value (t-test)*
1.	FVCI	2.93±0.52	2.91±0.46	0.836
2.	FEV_1I	2.46±0.64	2.69±0.49	0.071
3.	FEV_1/FVC%	1.65±0.62	1.90±0.57	0.069
4.	PEFRI/s	85.24±15.85	92.21±6.91	0.014*
5.	FEF_{25}I/s	4.88±1.68	5.46±1.88	0.145
6.	FEF_{25}I/s	4.44±1.71	5.05±1.79	0.123
7.	FEF_{50}I/s	3.74±1.44	4.42±1.52	0.041*
8.	FEF_{75}I/s	2.34±1.06	2.82±0.88	0.031*
9.	FIVCI/s	2.15±0.48	2.25±0.50	0.366
10.	PIFRI/s	2.88±1.11	3.64±1.11	0.003*
11.	FIF_{50}I/s	2.57±1.07	3.31±1.08	0.003*
12.	MVVI/min	80.02±27.06	92.36±30.06	0.008*
13.	IC I	2.17±0.47	2.35±0.39	0.077
14.	ERV I	0.78±0.47	0.58±0.41	0.046
15.	FRC I	1.80±1.12	1.14±0.57	0.002*
16.	RV I	1.04±0.91	0.57±0.23	0.003*
17.	TLC I	3.96±1.15	3.47±0.58	0.021*
18.	RV/TLC%	23.11±12.37	15.94±4.87	0.001*
19.	R_{aw}cm H_2O/I/s	4.82±5.67	4.56±5.82	0.840
20.	Kst I/cm H_2O	0.08±0.02	0.09±0.02	0.407
21.	SVC I	2.93±0.72	3.33±0.67	0.013*

*P<0.05

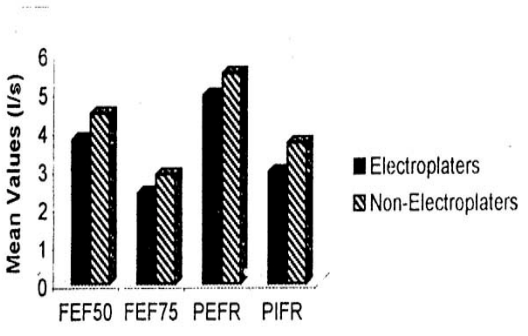

Fig. 3

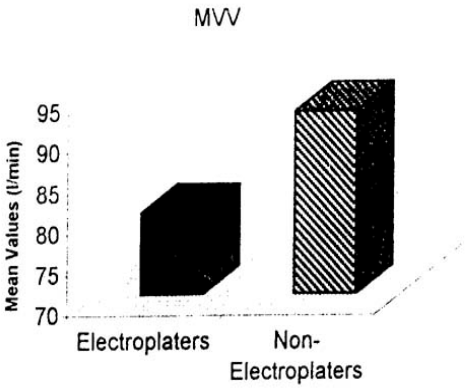

Fig. 4

DISCUSSION

Varied occupational factors including increased exposure to metals such as Cr, Cd, Co, Ni and Pb have been reported to deviate the pulmonary function test results in electroplaters culminating in acute and chronic diseases such as rhinitis, asthma, emphysema, chronic bronchitis, fibrosis and lung cancer (9–12–14).

Comparing our observed lung function test results with the normal predicted values, these indicate lower values for FEV_1/FVC%, $FEF_{50,}$ $FEF_{75,}$ PIFR, FIF_{50}, MVV and SVC and higher values for FRC, RV and RV/TLC% variables in electroplaters whereas these are quite matching in non–electroplaters. Similar patterns of results have also been reported earlier form our laboratory (Gupta et al).

Intergroup comparison between electroplaters and non–electroplaters showed that results of FVC is almost comparable in both the groups whereas $FEF_{50,}$ $FEF_{75,}$ PEFR, PIFR, FEV_1, SVC and MVV are decreased and RV and TLC are increased in electroplaters, depicting an overall compromised picture of lung functions in electroplaters.

Further comparing our results of FVC, FEV_1 and FEV_1,/FVC% with those of Gangopadhyay et al (15), and Arora et al who studied in male non–smoking steel plant workers of Durg, our results are lower than those of Gangopadhyay et al and higher with those of Arora et al (16) the workers studied by both researchers were non–smokers (ours are smokers) and those of Arora et al were in addition subjected to longer duration of work place exposure i.e. of more than 20 years (duration of exposure of our workers of Group I was 6.35± 4.96 years).

While comparing our results of FVC, FEV_1 and PEFR with those of hard metal factory workers exposed to Co, carried out by Shirakwa et al (17–18) et al, and Kusaka et al (19) in Europe, our results of electroplaters showed lower lung function values as against their's. The probable reason for this difference could be better anthropometric parameters and prevailing healthier workplace conditions of their workers. However, the smoking and work duration periods are quite comparable.

Due to the non–availability of more such reports from India and abroad we could not compare the lung function results further.

To conclude, it is stated that the electroplaters are exposed to heavy metals, which may affect the respiratory health in due course of time contributing a risk factor for mortality (20, 21, 22). Simultaneously we suggest more such measurements in larger population samples.

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