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EFFECT OF FORMALIN VAPOURS ON PULMONARY FUNCTIONS OF MEDICAL STUDENTS IN ANATOMY DISSECTION HALL OVER A PERIOD OF ONE YEAR

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Abstract : Formalin is extensively used for preservation of cadavers in department of Anatomy. However it is a noxious chemical which vaporises at normal room temperature in the air and may cause respiratory health problems among first year medical students. The study was planned to observe the effect of formalin vapours on lung function tests of first year medical students who are exposed routinely for 2 hrs every day for 6 days per week throughout the year. Following written informed consent clinically healthy 100 medical students between age group 18-23 yrs were subjected to pulmonary function testing by computerised spirometery. The dynamic lung function tests (FVC, FEV1, FEV1%, FEF_{25-75}, PEFR) were measured on four occasions-basal (before exposure), 1 month, 6 months, 11 months of exposure to formalin vapours in anatomy dissection hall. The study revealed statistically significant ($P<0.0001$) decreases in FVC, FEV1%, FEF_{25-75}, PEFR except FEV1 after 1 month of exposure to anatomy dissection hall. The decrease in all the parameters slowly reverted back towards normal basal values across 6 and 11 months and was statistically significant in all ($P<0.0001$) except FVC. Acute exposure to formalin vapours at anatomy dissection hall decreases the respiratory functions, however on long term exposure the body corrects the damage. Further studies are required to see the changes at cellular levels and the extent of damage to respiratory system.

Key words : formalin, pulmonary functions, anatomy, dissection hall

INTRODUCTION

Formalin is a colorless and irritative fluid that contains 37% of formaldehyde and is widely used as a preserving agent of biological specimen. At the medical and dental colleges formalin has been used for years to preserve cadavers. Recently, however formaldehyde has attracted much attention due to its health hazards. The

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primary route of exposure to formaldehyde is by inhalation, where it is absorbed by the lungs and also through gastrointestinal tract and to much lesser extent through the skin (1). Several published reports, research papers and industrial experience suggest that exposure to formaldehyde is associated with adverse effects on respiratory health (2). Recent review of the studies have indicated that upper respiratory tract is the critical target of the toxicity of air borne formaldehyde (3-6). Symptoms of upper airway irritation, including dry and sore throat, itching, burning sensation of the nose and nasal congestions have been reported by the workers (7). Studies in rats and mice using high concentration of formaldehyde over an extremely long period have reported to result in squamous carcinoma of nose (8). Occupational data suggests that small but significant changes may occur in lungs following prolonged exposure in the work place (7). It is also utilised by manufacturer of resins, plywood, leather good but exposure to formaldehyde in department of anatomy is continuous and higher than its use in other areas. The evaporation of formaldehyde from cadavers in anatomy dissection hall can produce high exposure among medical students and instructors (9). There has been an increasing number of reports that students suffer from various physical symptoms including burning eyes, lacrimation, irritation of airways, dermatitis with a high prevalence during gross anatomy dissection (3). In view of its widespread use, toxicity, and volatility, exposure to formaldehyde is a significant factor affecting human health (10). However only few studies have mentioned the effect of formalin vapours in anatomy dissection hall on pulmonary function tests of medical students. Therefore the study was planned with the aim to see effects of formalin on pulmonary functions in medical students who are exposed to formalin vapours for two hours every day for 6 days a week in anatomy dissection hall.

MATERIALS AND METHODS

The present study was carried out on 100 healthy medical students between age group 18-23 years. Prior approval from Research Committee and Institutional ethical committee was obtained. Subjects were recruited based on the subject proforma. Inclusion criteria being clinically healthy, non-smokers, without any chronic respiratory disease, systemic illness like diabetes, hypertension The pulmonary function tests were carried out using computerised spirometer (Spiro Lab-II). The flow, volume/ time graphs were taken out in accordance to the criteria based on American Thoracic Society (11). Following informed and written consent, the anthropometric measurement like height, weight were recorded. The pulmonary function were tested on four occasions –

1) Basal (before exposure to formalin)

2) 1month of exposure to formalin vapours

3) 6 months of exposure to formalin vapours

4) 11 months of exposure to formalin vapours.

The dynamic function tests-FVC, FEV1, FEV1%, FEF_{25-75}, PEFR were recorded. The lung function tests were repeated thrice on each occasion for each subject and the maximum reading was selected for analysis.

Statistical analysis

The data was collected and subjected to statistical analysis using SPSS ver19. After the anthropometric profile, the basal values of the dynamic lung function tests were compared with 1 month exposure to anatomy dissection hall by Paired Student's t test to look for acute changes. Variability in all dynamic lung function test within the subjects and across the time were analysed by repeated measures ANOVA and Post Hoc Bonferroni test. The level of significance was set at P<0.05.

RESULTS

The mean age (years) of the subjects in the present study was 18.32±1.1 (mean±SD). The mean height of these subjects was 166.8±9.1 cm and mean weight was 65.63±16.3 kg. The mean BMI of the subject was 23.45±5 (Table-I).

TABLE I: Anthropometric profile and basal parameters of dynamic lung function tests (n=100).

Baseline parameters	*Values*
Age (years)	18.32±1.1
Height (cms)	166.8±9.1
Weight (kg)	65.63±16.3
BMI (kg/m^2)	23.45±5
Basal FVC (L)	3.41±0.87
Basal FEV1 (L)	4.60±11.8
Basal FEV1%	89.91±13.6
Basal FEF_{25-75} (L/S)	4.29±1.4
Basal PEFR (L/S)	5.73±2.14

Values in mean±SD.

The dynamic lung function tests of subjects 1month after exposure to anatomy dissection hall for 2 hours/day 6 days a week showed statistically significant decrease in mean values of all the dynamic lung function tests (P<0.0001) except for FEV1. There were subjective complaints of mild irritation in the nose, lacrimation, redness of the eyes, dry throat, headache and itching in the skin (Table-II).

Table II: Comparsion of lung functions in students before and after exposure for 1 month to formalin in anatomy dissection hall (n=100).

Parameters	*Before exposure*	*After exposure (1 month)*
FVC (L)	3.41±0.87	2.94±0.8***
FEV1 (L)	4.60±11.8	2.41±0.8^{ns}
FEV1%	89.91±13.6	78.82±14.9***
FEF_{25-75} (L/S)	4.29±1.4	2.78±1.38***
PEFR (L/S)	5.73±2.14	3.61±1.95***

Values in mean±SD. *P value<0.05, **P<0.01,. ***P<0.001, ns-not significant.

Duration (in months) of stay in formalin vapours of anatomy dissection hall had statistically significant effect on the dynamic lung function tests (Table-III).

The mean value of FVC for the subjects at time of entry into the study was 3.41±0.87 L as compared to FVC at 1 month (2.94±0.8 L) 6 month (3.19±0.71L) and at 11 month (3.22±0.76 L). Comparsion of mean values of FVC reported statistically significant difference between basal and 1 month (P<0.0001), however rest all the values were statistically insignificant. The mean value of FEV1 for the subjects at time of entry into the study was 4.60±11.8 L which decreased drastically at 1 month and remained so by 11 month, and this decline was statistically significantly lower (P<0.0001). The mean of FEV1% of the subjects at time of entry into the study was 89.91±13.6 which decreased at 1 month (78.82±14.9), but was later

TABLE III: Comparison of dynamic function tests in medical students before exposure and after exposure to formalin in anatomy dissection hall (n=100).

Parameters	*Before exposure*	*After exposure (1 month)*	*After exposure (6 month)*	*After exposure (11 month)*
FVC (L)	3.41±0.87	2.94±0.8$^{\#\#\#}$	3.19±0.71	3.22±0.76
FEV1 (L)	4.60±11.8	2.41±0.8	2.72±0.73	2.94±0.62$^{\$\$\$}$
FEV1%	89.91±13.6	78.82±14.9$^{\#\#\#}$	83.60±14.35	89.72±6.81$^{\$\$\$,\wedge\wedge\wedge}$
FEF_{25-75} (L/S)	4.29±1.4	2.78±1.38$^{\#\#\#}$	3.33±1.24$^{\#\#\#}$	3.76±1.24$^{\$\$\$}$
PEFR (L/S)	5.73±2.14	3.61±1.95$^{\#\#\#}$	5.15±2.14$^{\$\$\$}$	5.16±1.97$^{\$\$\$}$

The values are mean±SD Statistical analysis done by Repeated Measures Anova and Post Hoc Bonferroni comparsion test for the variability in dynamic lung function tests within the subjects and across the time. The mark # indicate comparsion of values from basal reading; $ for comparsion with 1 month; ^ for comarsion with 6 month. $^{\#}$P<0.05, $^{\#\#}$P<0.01, $^{\#\#\#}$P<0.0001, $^{\$}$P<0.05, $^{\$\$}$P<0.01; $^{\wedge}$P<0.05; $^{\wedge\wedge}$P<0.01, $^{\wedge\wedge}$P<0.001.

restored back to normal by 11 months (89.72±6.81).

The mean of FEF_{25-75} of students at time of entry into study was higher (4.29±1.4 L/S) as compared to 1 month (2.78±1.38 L/S), 6 month (3.33±1.24 L/S) and 11 months (3.76±1.24 L/S). The values of FEF_{25-75} also became back towards normal by 11 months. The mean value of PEFR of the students at the time of entry into study was higher (5.73±2.14 L/S) which decreased at 1 month (3.61±1.95 L/S), but was later found to be increased by 11 months (5.16±1.97 L/S).

DISCUSSION

First year Medical students during their anatomy dissection classes are exposed to formaldehyde vapours, whose exposure is considered to be one of the cause of multiple chemical sensitivity. The binding of formaldehyde to endogenous proteins creates haptens that can elicit an immune response. Chronic exposure to formaldehyde has been associated with immunological hypersensitivity as measured by elevated circulating IgE and IgG autoantibodies to human sernum albumin. In addition, a decrease in the proportion of T cells was observed indicating altered immunity (12). Most of the students in our study complained of irritation in eyes, nose lacrimation, itching in skin.

In the present study acute exposure to formalin for 2 hrs/day for 6 days/week resulted in decrease in FVC, FEV1%, FEF_{25-75}, PEFR except FEV1 indicating mild bronchoconstriction. The study done earlier revealed that FVC decreased in subjects immediately after their first exposure, while all other lung function parameters remained unchanged indicating bronchoconstriction on acute exposure to formalin(7). Akbar-Khanzadeh et al evaluated acute pulmonary response in group of 34 workers exposed to formalin in gross anatomy dissection hall, also reported decrease in FVC but FEV1/FVC ratio increased during exposure (13). Farah Khaliq et al reported decrease in FVC immediately after 2 hours exposure to formalin. A trend towards decrease in values of FEV1 immediately after exposure was observed but it was not statistically significant (7). In the present study we also observed decease in FEV1 on acute exposure to formalin but it was not statistically significant (Table-II).

On the contrary, Chia et al reported no significant difference in the pre and post exposure in mean values of FVC and FEV1 (14). Alexanderson and Hedenstierna, evaluated lung function tests and immunoglogulin levels in 34 wood workers who were exposed to formaldehyde. A significant decrease in FVC, FEV1, FEF_{25-75} was reported (15). Mean while, the effect of formaldehyde exposure in plywood workers resulted in significantly reduced FEV1, FEV1/FVC ratio, FEF_{25-75} but not FVC (16).

In the present study there was a sharp decrease in dynamic lung function tests following 1 month of exposure, however the basal values were restored after 11 months of exposure to formalin vapours. A prospective study by Alexanderson R et al have reported significant decrease in FVC, FEF_{25-75}, FEV1% in wood worker who were exposed to formaldehyde since 4 years, however these decrements returned to normal after 4 weeks of nonexposure showing reversibility of pulmonary function tests following cessation of exposure (17). The exact concentration of formaldehyde to which our subjects were exposed in dissection hall could not be determined, which is the limitation of the study, but it is definitely at a concentration (2-3 ppm) causing severe eyes and nose irritation which was reported by the students following acute exposure (14).

For the numerous health challanges that formaldehyde causes on the students in anatomy dissection hall, it cannot be considered as an ideal chemical for embalming of cadaver. The laboratory attendents working in anatomy dissection hall for years are being continuously exposed to formalin vapours. They should be informed of potential health hazards of formalin and attempts should be done to reduce the concentration of formaldehyde by using other chemicals like glutaraldehyde, which can serve a good substitute for formaldehyde (18). As quoted by BS Mitchell "Reduction in formaldehyde concentration is not deleterious to specimen preservation, but leads to a safer working environment" (19).

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