Research Article

Acute effects of formalin on pulmonary function in medical students

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Abstract

Introduction: Formalin is used extensively as preservative, disinfective and embalming agent especially in the medical education. It has been reported that the formalin causes acute and chronic effects on health. **Aims and Objective**: To study the acute effects of formalin on pulmonary function in medical students. **Material and Methods:** Thirty young healthy male first year medical students in the age group of 18 to 22 years were included in this study group. Spirometry was performed on subjects before Anatomy dissection class and was repeated after two hours of dissection class. **Results:** The study revealed statistically highly significant ($p<0.05$) decrease in values of FVC, FEV_1 and PEFR after exposure but reverted back to normal within 24 hrs. But FEV_1/FVC ratio and $FEF_{25-75\%}$ did not show any significant change. **Conclusion:** Acute exposure to formalin vapours at anatomy dissection hall decreases the respiratory functions, however the body corrects the changes in respiratory function. Further studies are required to see the changes at cellular levels and the extent of damage to respiratory system.

Keywords: Pulmonary function test, Formaldehyde, Anatomy dissection.

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INTRODUCTION

Formalin is a colorless and irritative fluid that contains 37% of formaldehyde and is widely used as preservative, disinfective and embalming agent especially in the medical education. It has been reported that the formalin causes acute and chronic effects on health[1]. The 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[2]. Formaldehyde is quickly absorbed from the nose and the upper part of lungs. Once absorbed, formaldehyde is very quickly broken down. Almost every tissue in the body has the ability to break down formaldehyde. It is usually converted to a non-toxic chemical called formate, which is excreted in the urine and is converted to carbon dioxide and breathed out of the body. But formaldehyde can be toxic, allergenic, and carcinogenic[3]. It is well known that formaldehyde can cause sick house syndrome. Sick house syndrome (or sick building syndrome) is characterized by nonspecific complaints of mucosal irritation, headaches, and nausea and chest symptoms[4]. Several published reports, research papers and industrial experience suggest that exposure to formaldehyde is associated with adverse effects on respiratory health[5]. Recent review of the studies has indicated that upper respiratory tract is the critical target of the toxicity of air borne formaldehyde[6,7]. 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[8]. We have evaluated pulmonary functions among medical students exposed to formaldehyde for two hours during their Anatomy dissection, and have investigated the relation between exposure to formaldehyde and acute changes in respiratory function.

METHODOLOGY

Selection of participants

The study was carried out on thirty young healthy male first year medical students within age group of 18-22 years. The study sample was selected after screening for age, history of hypertension, cardiac or pulmonary

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diseases, smoking and alcohol consumption. Each participant provided written and informed consent.

Procedure

Spirometry was performed on subjects immediately before the start of dissection class and repeated after two hours of dissection class. Computerised Spirometer (RMS-Helios 702 Medspiror) was used to measure pulmonary function tests. This is solid state electronic equipment. The subjects were familiarized with the set up and detailed instructions and demonstrations were given to their satisfaction. The subject had to respire into a sophisticated transducer, which is connected to the instrument by means of a cable. Three to four trials of maximal inspiration and expiratory efforts were made and the highest reading was taken for data processing. The apparatus provides a detailed analysis of predicted and derived values. The computer printouts of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1), FEV_1/FVC ratio, Forced Expiratory Flow between 25% and 75% of vital capacity ($FEF_{25-75\%}$), and Peak Expiratory Flow Rate (PEFR) with graphic curves were obtained.

Statistical Analysis

The mean and standard deviation were used for descriptive statistics. Student's *t*-test was applied to determine the significance of values. One sample Kolmogorov-Smirnov test was used to test the normality of the data. p-values <0.05 was fixed for the statistical significance.

RESULTS

The mean age of the all the male subjects in the present study was 20±1.04 years. The mean height of the subjects was 168.70±8.25 cm and weight was 60.15±9.15 Kg. Almost all subjects complained about mild irritation in the nose and eyes. As shown in table, the decrease in values of FVC, FEV_1 and PEFR were statistically highly significant after exposure. The FEV_1/FVC ratio and $FEF_{25-75\%}$ did not show any significant change. Table-1 shows values of Pulmonary Function Tests in our subjects.

Table 1: The percentage predicted values of pulmonary function tests

Parameters	Pre-exposure	After-exposure
FVC	92.72±7.32	69.53±13.2*
FEV_1	102.43±6.18	82.45±12.32*
FEV_1/FVC	112.12±4.56	110.56±11.22
$FEF_{25-75\%}$	107.32±12.34	106.37±16.15
PEFR	90.25±10.14	73.92±8.65*

All the values are mean ± SD, n= 30 in each group, *p< 0.05

DISCUSSION

Formaldehyde (HCHO) is the gas produced by the oxidation of methyl alcohol. It is colourless and flammable with a strong pungent odour. Formaldehyde is extremely soluble in water and the aqueous solution containing some 37% formaldehyde is called formalin. Commercially available formalin is generally a solution containing 37% formaldehyde together with some 10-15% methanol to inhibit polymerisation[9]. It is used for disinfection or sterilization of instruments used for medical purposes. It is also used as a preservative of biological specimens as well as cadavers. Medical students during their dissection course are exposed to formaldehyde, whose exposure is recently considered to be one of the causes of multiple chemical sensitivity. Formaldehyde has eliminated many health hazards during histological procedures in anatomy and pathology laboratories. Paradoxically, formaldehyde itself is a noxious chemical, highly unpleasant to the user, and a well-recognized occupational health hazard. Formaldehyde has been reported to produce allergic contact dermatitis, neurobehavioral changes and carcinogenesis[10]. Occupational hazards of formaldehyde were thoroughly investigated but the studies were primarily dealing with its possible carcinogenic effects[11]. Only small proportion of studies were oriented towards inflammatory reactions of respiratory system relating exposure to formaldehyde fumes inhalation to dynamic changes (short-term and long-term) in bronchial and pulmonary symptoms and function. Various studies provided the evidences that formaldehyde is an irritant of the respiratory tract that causes nonproductive cough, breathing problems, eye tears and nose dripping. There is a correlation between clinical symptoms and concentration of formaldehyde in the workplace. Usual concentration provoking symptoms being from 10 to 20 ppm[12] In the present study, when all the above five parameters were taken together they all were reduced except FEV1/FVC ratio and $FEF_{25-75\%}$that was normal and indicated obstructive lung impairment. These can be attributed to the adverse effect of formalin on respiratory system. Various studies done earlier revealed that FVC decreased in subjects immediately after their first exposure. While all other lung function parameters remained unchanged, indicating some mild transient bronchoconstriction on acute exposure to formalin[8]. Akbar-Khanzadeh, *et al* reported that formaldehyde exposure, acute pulmonary response, and exposure control options were evaluated in a group of 34 workers in a gross anatomy laboratory and noted that Forced vital capacity (FVC) decreased, but FEV_1/FVC ratio increased during the exposure[13].Similarly, histology technicians (280 subjects) were shown to have reduced pulmonary function, as measured by FVC, FEV_1 and $FEF_{25-75\%}$compared with 486 controls[14]. Alexandersson and Hedenstierna, evaluated symptoms of irritation, spirometry, and immunoglobulin levels in 34 wood

workers exposed to formaldehyde over a 4-year period. Exposure to 0.4–0.5 ppm formaldehyde resulted in significant decreases in FVC, FEV_1, and $FEF_{25–75\%}$[15] Meanwhile, the effects of formaldehyde exposure in plywood workers resulted in significantly reduced FEV_1, FEV_1/FVC ratio, and FEF25–75% compared with controls but Forced vital capacity was not significantly reduced[16]. As for the other alternative chemicals in place of formaldehyde Glutaraldehyde is an aldehyde related to formaldehyde, with similar fixation qualities. It would be a feasible alternative, but because of the volumes that would be required, it is prohibitively expensive[5]. Also Reinhard Pabst in his follow up study has advocated the use of glutaraldehyde as a good substitute for formaldehyde[17].

CONCLUSION

It can be concluded that formaldehyde is toxic and causes impairments in lung functions, hence alternative chemicals like glutaraldehyde, which are safer and non toxic, have to be considered in place of formaldehyde.

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