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EFFECT OF ACUTE EXPOSURE OF FORMALDEHYDE ON PULMONARY FUNCTION TESTS OF FIRST YEAR M.B.B.S. STUDENTS

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ABSTRACT

AIMS: *The aim of this study was to assess the effects of acute exposure of formalin on the pulmonary function.* ***Methods:*** *The study group consists of 60 First M.B.B.S. Medical Students of Shri. Bhausaheb Hire GMC Dhule; (Male =30, Female =30) (mean age male = 18.55±0.685 yrs, female = 18.17±0.8481 yrs.) who were regularly exposed to formaldehyde in anatomy department two hours once a day for six days per week. Inclusion criteria was clinically healthy, non-smokers, without any chronic respiratory disease, systemic illness like diabetes, hypertension etc. This study was conducted after obtaining ethical clearance and consent. MEDSPIROR-COMPUTERISED SPIROMETER was used to find out the PFT at start of anatomy dissection (pre-exposure) and after 2 hours of dissection (post-exposure). The pulmonary function tests included were FVC, FEV1, FEV1/FVC, MVV and PEFR. All these parameters helped in evaluating pulmonary functions among medical students exposed to formaldehyde for two hours during their anatomy dissection.* ***Statistical Analysis:*** *The data was entered in the MS Excel spreadsheet. Appropriate statistical analysis was performed using SPSS. Paired students't' test was applied to compare the PFT parameters in Pre and post exposure changes. The data was expressed as mean ± standard deviation.* ***Result:*** *In the present study acute exposure to formalin resulted in significant decrease in FEV1, FEV1/FVC, MVV, PEFR but in FVC no significant change seen in male students and decrease in all parameters in female students following acute exposure.* ***Conclusion:*** *Formaldehyde causes obstructive changes in form of bronchoconstriction at some extent due to acute exposure.*

KEY WORDS

formaldehyde, pulmonary functions, anatomy dissection hall.

INTRODUCTION

Formaldehyde is a colorless, flammable gas at room temperature. It has a pungent, distinct odor and may cause a burning sensation to the eyes, nose and lungs at high concentrations. Formaldehyde is combined with methanol and buffers to make embalming fluid. Formaldehyde is also used in many hospitals and laboratories to preserve tissue specimens. Doctors, nurses, dentists, veterinarians, pathologists, embalmers, workers in the clothing industry or in furniture factories, and teachers and students who handle preserved specimens in laboratories also might be exposed to higher amounts of formaldehyde. At medical colleges formaldehyde has been used for years to preserve cadavers. Various complaints from medical students led to study its effects. Thus the study was planned with the aim to see effects of formalin on pulmonary functions in medical students who were exposed to formalin vapours for two hours every day for 6 days a week in anatomy dissection hall.

AIMS AND OBJECTIVES: The aim of this study was to assess the effects of acute exposure of formalin on the pulmonary function of first year M.B.B.S. students SBH GMC Dhule during dissection hours.

MATERIALS AND METHODS:

Selection and Description of Participants: The study was longitudinal study carried out on first M.B.B.S. students. The study group consist of 60 students (Male =30, Female =30) (mean age male = 18.55±0.685 yrs, female = 18.17±0.8481 yrs.) who were regularly exposed to formaldehyde in anatomy department two hours once a day for six days per week. The above students were having daily dissection class of two hours. Dissection hall was

having 10 dissection tables. One cadaver was given to 10 students, so there was equal exposure to all the subject. The relationship between exposure to formalin and change in pulmonary functions tests was compared prior to exposure and after two hours of dissection class in Department of Anatomy. Approval was taken from the institutional ethical committee.

Technical Information:

Project Instruments:

- Examination proforma for obtaining medical history and for recording clinical examination.
- Portable weighing machine was used to record the weight in kg.
- Measuring tape was used to measure the standing height in centimeters.
- MEDSPIROR - COMPUTERIZED SPIROMETER respiratory analysis system available in the research lab of Department of Physiology, SBH Govt. Medical College Hospital and Research center was used to perform the pulmonary function tests (PFTs).

History and Clinical Examination : A thorough history was collected from all the participants including personal history such as name, age, sex, ethnicity, address, habit of smoking and medical history including history of any respiratory and cardiac diseases. All the subjects underwent an anthropometrical assessment including standing height and weight. The subjects for this study were included based on the following criteria.

Inclusion criteria will be clinically healthy, non-smokers, without any chronic respiratory disease, systemic illness like diabetes, hypertension etc.

Exclusion criteria: Exclusion criteria were H/o chronic respiratory disease, H/o cardiac disease etc. Examination finding suggestive of respiratory or cardiac disease, abnormal pulmonary function test, extremes of weight and height, continuous 7 days absence from the class.

For pulmonary function test medspiror was used. Pulmonary function test was recorded in PFT laboratory at around morning session before the start of dissection so as to avoid any acute effect of formalin. On the previous day, students were told to avoid any physical exertion cm and take proper rest and diet. The data of the subject as regards. name, age, height, weight, sex, date of performing the test, atmospheric temperature was fed to the Spirometer. The tests were performed in sitting position. The subject was asked to take full inspiration which was followed by as much rapid and forceful expiration as possible in the mouthpiece of medspiror. Three consecutive readings were taken and the best reading amongst the three was selected. We have followed the guidelines of Americal Thoracic Society. [1] PFT was taken at start of anatomy dissection (pre-exposure) and after 2 hours of dissection. (Post-exposure). The pulmonary function tests included were forced vital capacity (FVC) [L], forced expiratory volume 1 s (FEV1) [L], FEV1/FVC, peak expiratory flow (PEFR) [L/S], maximum ventilation volume or maximum voluntary ventilation (MVV) carried out by computerized spirometer. All these parameters helped in evaluating pulmonary functions among medical students exposed to formaldehyde for two hours during their Anatomy dissection.

The procedure for doing test parameters for FVC, the subjects were asked to execute fast forceful expiration as much as possible at the end of deep inspiration. This test was repeated 2 or 3 times, and the best value was obtained. For MVV, the subjects were asked to inhale and exhale as deep and the fast as possible over a period of 12s during which recording were done.

Statistics:

The data collected was entered in the MS Excel spreadsheet. Descriptive table was generated, and appropriate statistical analysis was performed using SPSS (version 10). Student's t-test was applied to compare the PFT parameters between pre exposed and formalin post exposed group. A significance level of "P" < 0.05 was considered for the student's t-tests. The data were expressed as mean $\pm$ standard deviation.

RESULTS

The mean age (years) of the subjects in the present study was (mean ± SD): male=18.55 ± 0.685 yrs, female=18.17 ± 0.8481 yrs.

The mean height of these subjects was male=170.13 ± 5.99cm; female=158.62±3.93 and mean weight was male 59.069 ±10.54 kg; female=56.20 ± 11.87 kg.

TABLE I: Anthropometric profile (male n=30 and female n=30)

Basal Values	Male (n=30)mean±SD	female (n=30)mean±SD
Age (years)	18.55±0.685	18.17±0.8481
Height (cm)	170.13±5.99	158.62±3.93
Weight (kg.)	59.069±10.54	56.20±11.87

TABLE II: Comparison of lung functions in male students before and after exposure for 2 hours to formalin in anatomy dissection hall (n=male 30)

Parameters	Before Exposure mean±SD	After exposure mean+SD	P Value	Significance
FVC (L)	3.31±0.43	3.33±0.65^{ns}	0.84	Not significant
FEV1 (L)	3.13±0.40	2.82±0.69**	0.005	Significant
FEV1/FVC	94.52±5.13	84.20±14.63**	0.001	Significant
PEFR (L/S)	7.33±1.39	5.67±1.87***	0.000	Significant
MVV	107.76±15.71	105.38±21.38	0.000	Significant

TABLE III: Comparison of lung functions in female students before and after exposure for 2 hours to formalin in anatomy dissection hall (n=female 30)

Parameters	Before Exposure mean±SD	After exposure mean+SD	P Value	Significance
FVC (L)	2.54±0.46	2.45±0.53*	0.025	Significant
FEV1 (L)	2.40±0.42	2.22±0.509**	0.004	Significant
FEV1/FVC	95.66±3.76	93.28±5.10*	0.02	Significant
PEFR (L/S)	5.33±1.27	3.68±1.20***	0.000	Significant
MVV	95.38±11.32	87.66±15.71	0.000	Significant

Values in mean ± S.D. *P Value<0.05, **P<0.001, ***P<0.0001, ns=not specified

DISCUSSION

Formaldehyde is produced naturally by our bodies [2]. It is found in all cells and is a normal component of human blood. In fact, formaldehyde is an essential chemical in the body and serves as a building block for the biosynthesis of more complicated molecules. [3] Formaldehyde is one of the most studied chemicals in use today. Studies in rats, monkeys, and humans show that inhaled formaldehyde does not change the levels of formaldehyde normally present in the blood. [4]

At levels to which humans may be exposed, adverse effects are most likely to be observed primarily following inhalation. It has been experimentally proved that effects on organisms (e.g. mammals) are more closely related to concentration than to the accumulated total dose; this is due to the rapid metabolism and high reactivity and water solubility of formaldehyde. Dermal exposure predominantly affects the skin itself, and little if any formaldehyde reaches the blood stream. There is a relatively large exposure to formaldehyde from ingestion of flood, but most of it is present in a bound form.

Blood exchange is a critical form of exposure but is very rare, even in the very small segment of the population at risk [5].

Inhaled formaldehyde rapidly breaks down in the body from a gas into the soluble form of formaldehyde (methanediol) and then is changed into format in the nose and upper respiratory tract. Format is either used as a building block chemical for the body to make more complicated, larger chemical molecules or broken down into carbon dioxide,[6] which is exhaled in breath. The tiny fraction (i.e. <0.1%) of formaldehyde in the body that can exist in a gaseous form in small amounts (<0.8 ppb to 8 ppb; that is 0.001-0.01 mg/m^3) [7] is exhaled in the breath. Consequently, formaldehyde levels in the blood do not increase as a result of inhaled formaldehyde. [8]

In the present study acute exposure to formalin for 2 hrs/day for 6days/week resulted in decrease in FEV1, FEV1/FVC, PEFR, and MVV except FVC in male students in post exposure indicating mild broncho constriction. (Table no. II)

Exposure to moderate levels of formaldehyde (1-3 ppm) can result in eye and upper respiratory tract irritation [9, 10]. Feihman states that most people cannot tolerate exposures to more than 5 ppm

formaldehyde in air; above 10-20 ppm symptoms become severe and shortness of breath occurs. [11] High concentrations of formaldehyde may result in nasal obstruction, pulmonary edema, choking, dyspnea, and chest tightness [12,13] A medical intern with known atopy and exposure to formaldehyde over a period of 1 week developed dyspnea, chest tightness, and edema, following a final 2 hour exposure to high concentrations of formaldehyde [12]. Five workers exposed to high concentrations of formaldehyde from urea-formaldehyde foam insulation experienced intolerable eye and upper respiratory tract irritation, choking, marked dyspnea, and nasal obstruction [13]. However, the concentrative of formaldehyde and the contribution of other airborne chemicals were unknown in both of the reports.

A series of pulmonary function studies has been conducted in healthy non smokers and asthmatics exposed to formaldehyde vapour; generally, lung function was unaltered. Fifteen healthy non smokers and 15 asthmatics were exposed to 2.4 mg/m3 formaldehyde for 40 mintutes to determine whether acute exposures could induce asthmatic symptoms [14,15]. No significant airway obstruction, changes in pulmonary function or bronchial hyperreactivity were noted. Similar observations were made on a group of 15 hospital laboratory workers who had been exposed to formaldehyde. [16]

Lung function tests were performed on embalmers [17, 18], medical students [19] and anatomy and histology workers [20]. In most of the studies, formaldehyde alone or in combination with other agents caused transient, reversible declines in lung function, but there was no evidence that formaldehyde induces a chronic decrement in lung function. In BK Binawarastudy, highly significant ($p<0.001$) decrease in values of FVC, FEV1 and PEFR after acute exposure but reverted back to normal within 24 hrs. But FEV1/FVC ratio and FEF25-75% did not show any significant change [21]. 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, FEF25-75 was reported. [22]

In the present study there was a decrease in dynamic lung function tests FEV1, FEV1/FVC, PEFR, MVV and FVC in female students following acute exposure (Table No. III) 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 [23]. A trend towards decrease in values of FEV1 immediately after exposure was observed but it was not statistically significant [24]. In the study of ABHA SHRIVASTAVA AND YOGESH SAXENA 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 [25]. The effect of formaldehyde exposure in plywood workers resulted in significantly reduced FEV1, FEV1/FVC ratio, FEF25-75 but not FVC [26]. 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 [27].

CONCLUSION:

Formaldehyde causes obstructive changes as is evidenced by decrease in FEV1, FVC/FEV1, PEFR, MVV .It can cause broncho constriction at some extent due to acute exposure. It also decreases FVC in female students.

Scope of study: Study of use of mask can decreases various acute symptoms and need of further study of chronic effect of formaldehyde.

We would like to recommend proper ventilation system in the dissection hall and students should be allowed to use mask so as to reduce personal exposure.

REFERENCES

1. American Thoracic Society, An Rev Respir Dis 1987; 136; 1285-98.
2. WHO 2010 at pg. 122.
3. Neuberger A, 2005, The metabolism of glycine and serine. In Neuberger A., Van Deenen LLM, eds. Comprehensive biochemistry; Vol. 19A. Amino Acid metabolism and sulphur metabolism. Amsterdam, Elsevier, 1981:254-303 as cited in WHO, 2010 at pg. 108.
4. WHO, 2010. At pg. 108; Health and safety Guide No. 57, http 19 WHO p. 108 and p. 122-3.
5. Formaldehyde In : Wood dust and formaldehyde, Lyon International Agency for Research on Cancer, 1995, Pp. 217-362 (IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, Vol. 62)
6. WHO, p. 108 and p. 122-3.
7. WHO, p. 111.
8. Kimbell J.E. et al. 2001, Dosimetry modeling of inhaled formaldehyde; binning nasal flux predictions for quantitative risk assessment. Toxicological Sciences, 64:111-121 as reported in WHO, 2010, WHO

Guidelines for Indoor Air Quality; Selected Pollutants at pg. 108.
9. Weber – Tschopp A, Fisher T., Granjean E., Irritating effects of formaldehyde on men. Int occup Environ Health 1977; 39:207-218.
10. Kulle J.T. Sauder L. R. Hebel JR, Green D., Chatham M.D., Formaldehyde dose- response in healthy non smokers. J Air pollution control asso 1987;37:919-924.
11. Feinman SE, Editor, Formaldehyde sensitivity and toxicity, Boca Raton (FL); CRC Press Inc. 1988.
12. Porter JAH, Acute respiratory distress following formalin inhalation, Lancet 1975; 1:603-604.
13. Solomons K, Cochrane JWC, Formaldehyde toxicity; Part 1. Occupational exposure and a report of 5 cases, S Afr. Med. J 1984; 66:101-102.
14. SCHACHTER, E.N. ET. AL A study of respiratory effects from exposure to 2 ppm formaldehyde in healthy subjects. Archieves of environment health, 41:229-239 (1986.)
15. WITEK, T. J. ET. AL. An evaluation of respiratory effects following exposure to 2.0 ppm formaldehyde in asthmatics; lung function, symptoms, and airway reactivity. Archieves of environmental health, 42:230-237 (1987.) 13
16. SCHACHTER, E. N. ET AL. A study of respiratory effects from exposure to 2.0 ppm formaldehyde in occupationally exposed workers, Environmental research, 44:188-205 (1987).
17. LEVINE, R.J. ET AL. The effects of occupational exposure on the respiratory health of west Virginia morticians, Journal of occupational medicine, 26:91-98 (1984.)
18. HOLNESS, D.L. & NETHERCOTT, J.R. Health status of funeral service workers exposed to formaldehyde, Archives of environmental health, 44:222-228 (1989).
19. UBA, G. ET AL. Prosepective study of respiratory effects of formaldehyde among healthy and asthmatic medical students, American Journal of industrial medicine, 15-91-101 (1989).
20. KHAMGAONKAR, M.B. & FULARE, M.B. Pulmonary effects of formaldehyde exposure. An environmental epidemiological study. Indian Journal of Chest disease and alliedscicnes, 33:9-13 (1991).
21. BK Binawara, Rajnee, S. Chaudhary, KC Mathur. H Sharma, K. Goyal, Acute effect of formalin on pulmonary function tests in medical students. Pak J Physio 2010; 6(2) : 8-10.15.
22. Alexandersson R, Hedenstierna G. Pulmonary function in wood workers exposed to formaldehyde; a prospective study, Arch Environ Health 1986; 44(1); 5-11.
23. Akbar-Khanzadeh F., Mlynek JS, Changes in respiratory function after one and three hours of exposure to formaldehyde in non smoking subjects. Occup Environ Med. 1997, 54(5); 296-300.
24. Khaliq Farah, Tripathi Praveen, Acute effect of formalin on Pulmonary function in Gross Anatomy Laboratory, IJPP 2009;53: 93-96.
25. Effect Of Formalin Vapours On Pulmonary Functions Of Medical Students In Anatomy Dissection Hall Over A Period Of One Year Abha Shrivastava* And Yogesh Saxena Indian J Physiol Pharmacol 2013; 57(3) : 255-260.
26. Malaka T, Kodama AM, Respiratory health of plywood workers occupationally exposed to formaldehyde, Arch Environ Health 1990: 45(5) : 288-294.
27. Chia SE, Ong CN, Foo SC, Lee HP, Medical students exposure to formaldehyde in a gross anatomy dissection laboratory. J Am Coll Health 1992; 41(3); 115-119.

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