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Original Research Article

EMBALMING FLUID- A POISONOUS PRESERVATION POTION: EFFECTS ON PULMONARY FUNCTIONS OF STUDENTS

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ABSTRACT

Objective: To explore the effects of acute exposure of embalming fluid fumes on the pulmonary functions in first year medical students.

Materials and Methods: The present study was carried out on 40 healthy, non- smoker first year medical students. The participants were exposed to embalming fluid fumes during cadaver dissection for duration of two hours. Pulmonary Function Tests (PFTs) were performed with computerized spirometer, prior to and immediately after the exposure. The outcome measures were Vital capacity (VC), Forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, Peak Expiratory Flow Rate (PEFR), $FEF_{25-75\%}$ and subjective symptoms reported by participants.

Results: The acute exposure of embalming fluid fumes was associated with significant decrease in FEV1/FVC ratio and $FEF_{25-75\%}$. Rest of the respiratory parameters did not show significant changes. The chief subjective complaints of the participants were pungent smell (92%), throat congestion (72%), burning sensation in eye (70%), headache (60%), nausea (52%) and rhinorrhoea (45%).

Conclusion: The acute exposure to fumes of embalming fluid during cadaver dissection was suggestive of respiratory function dysfunction at the level of mid-airway obstruction and mucosal irritation.

KEY WORDS: Embalming fluid fumes, FEV1/FVC ratio, $FEF_{25-75\%}$.

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INTRODUCTION

Cadaver dissection is an integral and essential part of first year medical curriculum. To preserve the internal anatomical details and arrest the decay of body, preservatives are routinely applied. The technique of preserving the body is known as 'embalming' and the mixture of fluid applied is known as embalming fluid. The typical embalming fluid used in our department is a mixture of various chemicals like formaldehyde, methyl alcohol, phenol, glycerine, eosin, cetrimide, thymol crystals in water [1-3].

The chief constituent of embalming fluid is formalin as it prevents putrefaction of body and retains the normal anatomical relations. The fixative properties of formalin is attributed to irreversible cross-links formation with macromolecules like proteins, DNA and RNA[4]. Formalin is an aqueous solution of 37% formaldehyde with low boiling point (-19^0 C). It releases irritant, pungent vapours at normal room temperature. In the dissection hall, teaching staff,

medical students, and technical staff are regularly exposed to irritant formaldehyde vapours during cadaver dissection[5]. However, because of easy availability and low cost, formalin is still the main constituent of embalming fluid across the medical colleges in India.

Research has shown that formaldehyde may cause impairment in pulmonary functions and asthma like reactions in sensitized individuals[6, 7]. The probable mechanism by which it may cause respiratory symptoms is due to high local absorption in the upper and mid-respiratory airways as 95% of inhaled formaldehyde is rapidly absorbed in the mucosa[8].

In the present study we have explored the effects of acute exposure of embalming fluid fumes on pulmonary functions in first-year medical students and tried to identify the probable anatomical site within the trachea-bronchial tree which could be correlated with pulmonary dysfunction.

MATERIALS AND METHODS

Objective: To explore the acute effects of two hours exposure of fumes of embalming fluid on pulmonary functions during cadaver dissection.

Study Design: Pre- and post-exposure study.

Participants: Forty first year medical students fulfilled the inclusion criteria and participated in the study. Ethical clearance for the study was obtained from institutional ethics committee for participation of human subjects. We briefed the participants about the study protocol and obtained written informed consent. Only participants without recent history of medical or surgical illnesses were recruited for the study. All participants were exposed to the cadaver dissection and embalming fluid for the first time. Students who were smokers, asthmatics, or had any history suggestive of respiratory or systemic disease, had family or personal history of allergic diseases or suffered from recent upper respiratory illness were excluded from the study.

Intervention: Two-hour exposure of embalming fluid fumes in anatomy dissection hall during cadaver dissection.

Pulmonary Function Tests: PFTs were carried out twice i.e., pre- and post-exposure using computerized spirometer (RMS–helios 401) with built in computer program. Three readings of the PFTs were recorded for each session and the best value out of three was selected for analysis.

Outcome measures: Forced Vital capacity (FVC), Forced expiratory volume in 1 second (FEV1),

FEV1/ FVC ratio, Peak Expiratory flow Rate (PEFR), Forced expiratory flow ($FEF_{25-75\%}$), Questionnaire related to symptoms (eye, nose, throat and nervous system).

Statistical analysis: All values were expressed as means ± standard error of the mean. Pre- and post-exposure comparisons were made using paired student's t-test. All analyses were done using SPSS Rel. 13.0 statistical package (SPSS Inc., Chicago, IL, USA). A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of participants was 18.2 ± 2.1 years ranging from 17-21 year. Sixty four % participants were male and the 36% were female. The acute exposure of embalming fluid fumes was associated with statistically significant decrease in FEV1/FVC ratio and $FEF_{25-75\%}$ and no changes in FVC, FEV1 and PEFR (Table 1). Ninety two % participants reported pungent smell, 72% throat congestion, 70% burning sensation in eyes, 60% headache, 52% nausea and 45% rhinorrhea (Table 2).

Table 1: Pulmonary Function Tests: pre and post exposure, AIIMS Rishikesh (N=40).

Parameters	Pre exposure		Post exposure		t value	p value
	Mean	SD	Mean	SD		
FVC (L)	3.56	0.93	3.6	0.88	-0.8	0.42
FEV1(L)	4.29	8.08	3.06	0.69	1	0.32
FEV1/FVC (%)	87.08	5.79	85.72	6.41	2.083	0.044
FEF_{25-75}(L)	3.65	1.07	3.44	0.97	2.52	0.016
PEFR(L/sec)	6.78	1.77	6.9	1.7	-1.06	0.29

Table 2: Subjective symptoms of participants, AIIMS Rishikesh (N=40).

CNS	Headache (60%)	Nausea (52.50%)	Vomiting (5%)	Drowsiness (12.5%)	Giddiness (20%)	Light headedness (5 %)
Eye	Itching (35%)	Burning (70%)	Lacrimation (50%)		Reddening (20%)	
Nose	Pungent smell (92.50%)	Crusting (12.5%)	Rhinorrhoea (45%)		Sneezing (7.5%)	
Throat	Irritation (10%)	Dryness (22.5%)	Coughing (30%)		Congestion (72.50%)	

DISCUSSION

The acute exposure of fumes of embalming fluid was associated with significant reduction in FEV1/FVC ratio and $FEF_{25-75\%}$. The FEV1/FVC ratio decreased by 1.6%, while $FEF_{25-75\%}$ by 5.8%. The FEV1/FVC ratio is one of the well known markers of obstructive type of lung diseases[9]. $FEF_{25-75\%}$ flow rate is suggestive of anatomical region of mid-airway flow pathology[10]. In our study significant reduction in FEV1/FVC ratio and $FEF_{25-75\%}$ and no change in PEFR is suggestive of mild mid-airway obstruction after exposure to embalming fluid fumes.

Literature findings of formalin exposure and PFTs are varied and heterogeneous. Chia, *et al* studied 150 first-year medical students exposed to formaldehyde during the dissection of cadavers in a gross anatomy laboratory and reported no significant difference in the pre- and post-exposure FEV1 and FVC values[11]. Khalif *et al* reported that FVC decreased in participants immediately after first exposure while all other lung function parameters remained unchanged [12].

Binawara reported decreased values of FVC, FEV1 and PEFR and no change in FEV1/FVC ratio and $FEF_{25-75\%}$ in male participants and all changes reverted back to normal within twenty four hours[13]. On the contrary, study by Akbar-Khanzadeh, et al showed FVC to decrease while FEV1/FVC ratio to increase with exposure[14]. The varied and heterogeneous effect of formalin on PFTs may due to different study settings, differential exposure duration, procedure of recording PFTs, basal exterogenous pollutants in the atmosphere and other variables.

Formalin exposure is a proven hazard for asthmatics[15]. In our study nearly all participants reported symptoms related to eyes, nose, throat and nervous system. Literature reports that formalin exposure to concentration as low as 0.1 to 3.0 ppm can cause burning of the eyes, increased lacrimation, and upper respiratory tract symptoms [16-18]. Higher levels (10-20 ppm) may produce cough, tightening in the chest, a sense of pressure in the head and exposures of 50-100 ppm or more can cause serious injury, including pulmonary edema, pneumonitis, or death [19]. During the cadaver dissection the personal exposure of formalin to the student is even more than average indoor concentration[20]. Therefore, we can infer in our experimental setting the reporting of cough, headache, eye and nose symptoms in significant number of participants is indirectly indicative of low to moderate level of formalin concentration in our dissection hall.

Formaldehyde has been classified by the International Agency for Research on Cancer (IARC) as “carcinogenic in humans” (class 1); however it is still widely used in anatomy and pathology departments for the fixing and conservation of biological tissues. Its use therefore raises the question of occupational hazard [21].

As the subject of anatomy is the foundation on which the whole medical curriculum would be laid down, health of first year medical students should not be compromised in dissection halls. The authors therefore suggest strict institutional policies to be formulated regarding proper ventilation and exhaust facilities in dissection halls, a regular assessment of formalin concentration and use of safer fixative agents like gluteraldehyde for cadaver preservation. Personal protective measures like masks containing activated carbon in dissection halls should be considered and practiced. Special screening and precautions are required for asthmatics and allergy prone medical students prior to the commencement of dissection classes.

CONCLUSION

The acute exposure to embalming fluid fumes during cadaver dissection by the first year medical students could be suggestive of pulmonary dysfunction owing to mid-airway obstruction and mucosal irritation. Guidelines for regulation of concentration and duration of exposure to embalming fluid fumes should be formulated and monitored in the dissection halls.

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Conflicts of Interests: **None**

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