



Physiology

A STUDY TO ASSESS ACUTE PHYSICAL REACTIONS EXPERIENCED BY FIRST YEAR MEDICAL STUDENTS ON EXPOSURE TO FORMALDEHYDE DURING GROSS ANATOMY DISSECTION

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ABSTRACT Medical students are exposed to formaldehyde regularly during gross anatomy dissection classes as the cadavers are embalmed with formalin, which on vapourization yields formaldehyde. They develop various physical reactions, most commonly irritation of mucosal surfaces of the nose, eyes and throat. The present study was done to evaluate these symptoms and how they change longitudinally over one month of exposure. Descriptive statistics and Wilcoxon signed rank test were applied for analysis. A p-value < 0.05 was considered significant. High incidence of eye and nasal irritation was noted along with a few others. After one month, a significant decline in throat irritation, unpleasant odour, nausea and headache was observed, while in others the decrease was non-significant. The wide spectrum of physical reactions demonstrates the detrimental effect of formaldehyde in the body. We should therefore ensure reduction of exposure by use of protective goggles, masks, improving ventilation and preventing unnecessary spillage of the formalin within the dissection hall.

KEYWORDS : Physical reactions, Medical students, Formaldehyde

INTRODUCTION

Formaldehyde is one of the occupational hazards faced by a doctor during the phase of medical education and training. It is an aldehyde produced by the oxidation of methyl alcohol. At room temperature, it exists as a gas which has noxious and irritating properties. Formalin is 37% aqueous solution of formaldehyde¹. It has innumerable utilities from sterilization of instruments, preservation of biological specimens to embalming of cadavers. A medical student learns about the body's anatomy by meticulous dissection of these formalin-embalmed cadavers, thereby providing a portal of consistent exposure for the entire first year, and often the exposure-rates are high^{2,3}.

The existing medical literature today shows that formaldehyde can be toxic, allergenic and even carcinogenic^{4,5}. The first experience of dissection is one of the most profound experiences of a doctor's life but, it is a common experience that medical students suffer from various physical symptoms like burning sensation in eyes, lacrimation, headache, nausea, irritation of airways and dermatitis, which has also been substantiated in numerous studies^{6,7,8}.

Formaldehyde concentrations above 0.1ppm in the ambient atmosphere are reported to cause mucosal irritation, neurological effects and increased risk of asthma and allergies and levels more than 0.5ppm, in addition to the above symptoms, also cause altered pulmonary functions. The mucosal irritation symptoms are the commonest and most distressing. Formalin is also attributed for 'sick house syndrome' or 'sick building syndrome' which is characterized by nonspecific complaints of mucosal irritation, headache, nausea and chest symptoms⁹. However, studies regarding the longitudinal evaluation of these reactions are very scarce. The present study was therefore intended to evaluate the occurrence of various acute physical reactions over a period of one month.

MATERIAL AND METHODS

A longitudinal, descriptive study was conducted in the Department of Physiology, Rohilkhand Medical College and Hospital among first year MBBS students in the academic year 2015-16. Approval was obtained from the Institutional Ethics Committee (vide document IEC/IRB No. IEC/27/2015). Students having no history of previous exposure to formalin by inhalational route or direct contact were considered as subjects. The exclusion criteria comprised of presence of pre-existing mucosal irritation symptoms of eyes, nose and throat, etc, any acute or chronic inflammatory state, allergic dermatitis and history of food, drug or chemical hypersensitivity. Students those who were not willing to participate were also excluded from the study. Eighty (80) medical students out of the total 150 students, who suitably fulfilled these criteria, were selected using simple random sampling technique. Informed consent was taken from every participant after explaining the nature of the study. Various physical reactions were recorded on a pre-designed structured questionnaire which comprised of various symptoms. They were arranged in a format that also allowed for a subjective grading of increasing level of discomfort of a particular symptom into absent, mild, moderate and severe intensities. The first recording was done within 24 hours of first exposure to formalin and the second after one month. Descriptive statistics and suitable statistical tests like Wilcoxon signed rank test were applied. A p-value < 0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

The response rate was 100% and the various physical reactions, both within 24 hours of first exposure and after one month of exposure have been shown in Table 1. Those with positive subjective experiences were further graded into mild, moderate and severe intensities of perception of the symptom. Though a general decline in the physical reactions was seen after one month, a statistically significant decrement in occurrence was observed only with regard to throat irritation, unpleasant odour, nausea and headache.

TABLE 1: COMPARISON OF DIFFERENT PHYSICAL REACTIONS AFTER FIRST AND AFTER ONE MONTH OF EXPOSURE.

Physical reactions	After first exposure				After one month				Wilcoxon signed rank test	
	Present			Absent	Present			Absent	Test-value (Z)	P-value
	Mild	Moderate	Severe		Mild	Moderate	Severe			
Eye irritation	3	46	31	0	12	39	29	0	-1.336	0.18
Nasal irritation	6	60	14	0	3	25	35	17	-1.046	0.30
Throat irritation	34	18	0	28	34	13	14	19	-2.555	0.01
Unpleasant odour	4	69	7	0	30	36	1	13	-5.652	0.00
Nausea	34	16	0	30	26	5	0	49	-3.249	0.00
Headache	31	19	0	30	33	7	0	40	-2.280	0.02
Unusual fatigue	33	15	0	32	25	13	0	42	-1.351	0.18
Suffocation	4	0	0	76	2	0	0	78	-0.816	0.41

The most distressing and the earliest physical reaction in the experience of the students have been shown in Table 2.

TABLE 2: EXPERIENCES ABOUT PHYSICAL REACTIONS

Sl no.	Symptoms	Percentage
Most troublesome and distressing symptom		
1	Eye irritation	68.8%
2	Nasal irritation	8.8%
3	Unpleasant odour	3.8%
4	Throat irritation	6.3%
5	Unusual fatigue	6.3%
6	Nausea	3.8%
7	Headache	2.5%
Earliest symptom to develop		
1	Unpleasant odour	40%
2	Nasal irritation	33.8%
3	Eye irritation	22.5%
4	Throat irritation	2.5%
5	Headache	1.3%

DISCUSSION

The occurrence of various physical reactions after exposure to formaldehyde is in consonance with similar studies by other researchers and the biological behaviour of formaldehyde. The fundamental physiological basis of all these diverse effects is proposed to be the high reactivity of formaldehyde. The oxygen atom of aldehyde group of formaldehyde is highly electronegative. It can react easily with nucleophilic sites on cell membranes, amino groups in protein, DNA, etc and subsequently form cross-links¹⁰. High incidence of eye irritation has also been reported by Neginhal R *et al*¹¹, Akbar-Khanzadeh F *et al*², Kundu S & Gangrade P¹², Patil GV *et al*¹³, Elshaer NSM *et al*¹⁴, Jain SR *et al*¹⁵, Hemalatha NR *et al*¹⁶ and Bindra GS *et al*¹⁷. The effect on eyes can be explained by the irritant effect of formaldehyde on tissues¹⁸. Formaldehyde vapour possibly excites mast cells in the conjunctiva and causes release of inflammatory mediators like histamine, serotonin, etc which result in redness, irritation and lacrimation. Formaldehyde also gets dissolved in the tear film due to its high water-solubility and then causes ocular irritation. With regard to nasal irritation, high incidence was also reported by Kundu S & Gangrade P¹², Neginhal R *et al*¹¹, Elshaer NSM *et al*¹⁴ and Akbar-Khanzadeh F *et al*². Incidence of throat irritation in the present study was similar to studies by Elshaer NSM *et al*¹⁴, Patil GV *et al*¹³, Jain SR *et al*¹⁵. As formalin vaporizes at room temperature, inhalational route is the main mode of exposure. Near 100% absorption of formaldehyde vapour occurs from the nasal mucosa, trachea and bronchi in humans¹⁹. So, nasal and throat mucosa are easily affected. The incidence of unpleasant odour was also quite high in our study. It is in near resonance with Elshaer NSM *et al*¹⁴ and Kundu S & Gangrade P¹². The high incidence of this symptom can be explained by the low sensory threshold of odour. It has been calculated that the lowest concentration of formaldehyde that is detectable by smell is 0.05 mg/m³ which comes out to be around 0.04 ppm²⁰. With regard to headache and nausea, the results of the present study were in accordance to the findings of Oniyje FM *et al*²¹ and Elshaer NSM *et al*¹⁴. A small proportion of the students also had an experience of suffocation. The experience of these symptoms can be explained by the phenomenon of sick house syndrome or sick building syndrome caused by formaldehyde. These are further amplified by the fact formaldehyde depresses the mucociliary clearance of the upper respiratory tract, paranasal sinuses, etc¹⁹. Therefore inflammatory changes of the mucosa in the setting of a delayed ciliary clearance especially in the sinuses might also contribute to these symptoms. Unusual fatigue and discomfort could be due to the cumulative effect of all other physical reactions. The experience of the reactions decreased with repeated exposures over one month suggesting that our body acclimatizes to the effects of this substance to a certain extent.

CONCLUSION

The present study demonstrates that there is a deleterious effect of formaldehyde on body which manifests in the form of multiple physical reactions. Apart from its health-related impediments, it can also result in an aversion towards the dissection hall among the students, impacting their learning and proficiency in the long run. We must therefore make concerted efforts to reduce exposure to formaldehyde by practicing simple steps like use of masks, goggles,

improving the ventilation across the dissection hall and avoiding unnecessary spillage of formalin within the dissection hall. Options like modifying the conventional process of embalming are also being considered in some places.

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