Research Article

Acute effect of formalin inhalation on peak expiratory flow rate in the first year medical students

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Abstract

Introduction: Formaldehyde has potent irritant effect on upper respiratory tract. Both pneumonitis and asthma have been reported after long term exposure to formalin. The aim of this study thus, was to assess the acute effect of formalin inhalation on Peak expiratory flow rate which should be reduced if there is bronchospasm. **Methods:** 60 first year medical students (both male and female) were tested before and after exposure to formalin while working in the anatomy dissection. PEFR was measured by Wight's mini peak flowmeter first before entering the dissection hall and, second just after coming out of dissection hall. The largest value from at least three acceptable blows is recorded. **Results:** The PEFR was significantly reduced after exposure to formalin in the dissection hallin all subjects as well as in the two gender groups ($p<.001$). **Conclusion:** There is significant acute bronchospasm due to exposure to formalin though long term effects of exposure to formalin are yet to be determined.
Keywords: formalin inhalation.

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INTRODUCTION

Formaldehyde is one of the commonest preservative used in anatomy dissection hall for preservation of cadavers. First year medical students are exposed to formalin for at least two hours in a day. Formaldehyde has been reported as a potent irritant to the upper respiratory tract. Various studies have reported that formaldehyde fumes when inhaled induces bronchospasm.[1] This may lead to various respiratory problems in people exposed to formalin. Same may happen to the first year medical students. The upper respiratory tract involvement in the medical students due to exposure of formaldehyde can be easily measured with the help of peak flowmeter. Peak flowmetry is a simple and effective measure of changes in upper respiratory airway diameter. PEF is the highest flow achieved from a maximum forced expiratory maneuver started without hesitation from a position of maximal lung inflation[7,11]. Measurement of PFER is also used to see progress of treatment in asthma-management programs.[10,11] The effect of the exposure at work can also be studied by examining the changes in peak expiratory flow rates (PEFR) and non-allergic bronchospasm. Burge and co-workers[2,3] were the first to propose serial assessment of peak expiratory flow rates at work and away from work. Aconsistent relationship has been observed between particulate pollution and lung function, principally peak expiratory flow rate (PEFR), despite differences in definitions of outcome measurements and statistical methods used to model the relationship between air pollution and health[12]. Various epidemiologic researches, however, have shown associations between common indoor materials or their emissionsin residences, and a variety of adverse respiratory and allergic health effects, including increased risk of asthma, pulmonary infections, and allergy. The identified risk factors include specific organic compounds such as formaldehyde, benzene, and phthalate esters, indoor materials or finishes such as carpet, flexible flooring, paint, and plastics, and indoor activities related to these materials PEF[5]. Thus from

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above all, it was assumed that the medical students are at most risk of having non allergic asthma due to prolong exposure with the formalin in the dissection hall. There are very few research article regarding this topic. Henceforth the present study is conducted to identify the effects of formalin on the first year medical students.

MATERIALS AND METHODS

Study design: It is a cross sectional study.

Subject selection: 60 healthy young individuals,30 males and 30 females of 18 -22 years were enrolled in the study. Only the subjects not having any cardiovascular or pulmonary disorders were included in the study.

Materials

Peak flow meters play an important role in the management of asthma for a large number of patients, by indicating the how narrow or open the airways are. Peak flow readings are higher when patients are well, and lower when the airways are constricted. The measurement of peak expiratory flow (PEF) was pioneered by Dr. B.M. Wright, who produced the first meter specifically designed to measure this index of lung function. Since the original design of instrument was introduced in the late 1950's, and the subsequent development of a more portable, lower cost version (the 'Mini-Wright' peak flow meter), other designs and copies have become available across Europe and the World.

Methods

For the present study, the subjects were called in the laboratory in morning hours. Detailed history regarding any respiratory or cardiovascular pathology was taken and their general and systemic examination was done. The subjects strictly fitting the above mentioned criteria were selected for the study. The subjects were then asked to a rest for at least 10 minutes. The PEFR was measured in the subjects with the help of mini Wright's peak flowmeter. The procedure of recording PEFR was conducted twice. One in the morning hours before entering the dissection hall and, second just after coming out of dissection hall. Subject cooperation is essential as the test results of PEFR is dependent on effort and lung volume, with PEF must be achieved as rapidly as possible and at as high a lung volume as possible, in order to obtain the maximum value[7,13]. The subjects were encouraged to blow as vigorously as possible. The neck was kept a neutral position, not flexed or extended, and the subject were asked not to cough during procedure. After the deepest possible inspiration, the subjects were asked to deliver the blow without any delay. Hesitating for as little as 2 s or flexing the neck allows the tracheal visco-elastic properties torelax and PEF to drop by as much as 10%[7,14]. Tonguing, spitting or coughing at the start of the blow may falsely raise the recorded PEF in some devices so, that was avoided. The subjects were given proper instruction, demonstration and practice before starting the maneuver. The subjects were asked to perform a minimum of three PEF maneuvers. Regular checks of the subject's PEF technique and meter are an important part of the procedure.

Within-maneuver evaluation

The subject were observed to ensure a good seal at the mouth, no hesitation occurred, and there was no abnormal start to the maneuver.

Between-maneuver evaluation

The PEF values and their order were recorded so that maneuver-induced bronchospasm could be detected. If the largest two out of three acceptable blows are not reproducible within 40 L/min, up to two additional blows can be performed. If satisfactory repeatability has not been in achieved in five attempts, more are not were not attempted as it might give faulty results[15].

Test result selection

The largest value from at least three acceptable blows is recorded.

Statistical analysis

We analyzed the results by paired Student's t-test for the effect of formalin on the PEFR. The software for the statistical analysis used was SPSS.

RESULTS

Table 1: Comparison of PEFR in All Subjects **1A:** Paired Samples Descriptive Statistics

	Mean	N	SD	SEM
Before exposure	470.00	60	67.42	8.70
After exposure	438.67	60	63.04	8.14

Table 1B: Paired Samples Student's t test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	SEM	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	before and after exposure	31.33	10.81	1.40	28.54	34.13	22.45	59	0.000

Table 2: Comparison of PEFR in Males **2A:** Paired Samples Descriptive Statistics

MALES	Mean	N	SD	SEM
PEFR before exposure	528	30	41.14	7.51
PEFR after exposure	493	30	37.34	6.82

Table 2B: Paired Samples Student's t Test

MALES		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	SEM	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PEFR before exposure and PEFR after exposure	35	12.53	2.28	30.32	39.68	15.31	29	0.000

Table 3: Comparison of PEFR in Females **3A:** Paired Samples Descriptive Statistics

FEMALES		Mean	N	SD	SEM
Pair 2	PEFR before exposure	412.00	30	24.41	4.46
	PEFR after exposure	384.33	30	24.17	4.41

Table 3B: Paired Samples Student's t Test

FEMALES		Paired Differences					t	df	Sig. (2-tailed)
		Mean	SD	SEM	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 2	PEFR before exposure and PEFR after exposure	27.67	7.28	1.33	24.95	30.38	20.82	29	0.000

From the above tables it was found that the PEFR of all subjects when compared before and after exposure to formalin were significantly ($p < 0.001$) lowered. Also, when PEFR compared separately in males and females, both gender groups showed significantly ($p < 0.001$) lowered after exposure to formalin.

DISCUSSION

As shown in results ($p = 0.000$), there was a statistically significant reduction in PEFR in the subjects after acute exposure to formalin. According to available literature[4], in medium concentration, formalin cannot penetrate beyond the major bronchi thus may cause irritation to nasal cavity lining, pharyngitis and bronchospasm of major bronchi only. But, in large concentrations acute exposure may lead to laryngospasm and pulmonary edema. Recognition of numerous sources of formaldehyde in indoor environments has increased concerns about health hazards from this pollutant. The effects of formaldehyde on the airway are proportional to the concentration and duration of exposure and are greater in inflamed than in healthy airways. It means that the subjects who are already having upper airway diseases are more likely to have precipitation of bronchospasm with formalin exposure. Formaldehyde may induce features of airway inflammation associated with asthma, such as epithelial disruption, microvascular leakage and increased airway secretions. Exposure to this chemical may facilitate IgE sensitization to a variety of allergens, as well as producing IgE-mediated allergic responses to itself[16]. It was reported by Ki-Hyun Kim *et al* that the likelihood for the development of allergic asthmaincreases proportionately with level of indoor formaldehyde concentration, especially when levels exceed 0.08 ppm.[4] In another study done in physiotherapy students[6], in anatomy dissection hall the formaldehyde exposures in the breathing zone ranged from 0.49 to 0.93 ppm (geometric mean ± geometric SD, 0.73 ± 1.22) i.e. much higher than 0.08 ppm. By the above mention reference we can assume the formalin levels in dissection hall in our study must also be higher than 0.08 ppm[4]. However, Mathur *et al* in their study found decrements in lung functions in exposed subjects compared to controls but these were not found to be statistically significant[8]. As formalin is a respiratory irritant it may aggravate the already existing childhood asthma although we did not have any such subject in our study who had childhood asthma but, as we are going to continue this study we may have such subjects. Efforts are being carried out to reduce the formaldehyde concentration in cadavers by using certain other cadavers. In one study, two commercially available chemicals, InfuTrace and Perfect Solution were evaluated, for their effectiveness in reducing ambient formaldehyde levels. Results indicated that both Perfect Solution, substituted for standard formaldehyde embalming, and InfuTrace infused through the vasculature after formaldehyde embalming, resulted in lower concentrations of formaldehyde than embalming with formaldehyde solution alone or in combination with body cavity injection of InfuTrace[8].

CONCLUSIONS

There was significant reduction in PEFR indicating acute bronchospasm due to exposure to formalin in the subjects enrolled in the study; though long term effects of exposure to formalin are yet to be determined. Thus, avoidance of formaldehyde exposure may reduce the incidence and severity of asthma, although the ability of low concentrations of formaldehyde to trigger mechanisms contributing to asthmatic symptoms is still not clear. Setting appropriate exposure limits for formaldehyde as an indoor environmental pollutant requires further quantitative and predictive evaluation of its health.

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