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Effect of Formaldehyde on Pulmonary Parameters in Medical Students – An observational study

Dr. V Ravi Kumar[1]; Dr. M.C. Sudhakaran[2]; Dr Vaibhav Anjankar[3]

[1]Tutor, Dept. of Physiology, Andaman & Nicobar Islands Institute of Medical Sciences (ANIIMS), Port Blair, India

[2]Associate Professor; Dept. of Physiology, Govt. Medical College Idukki, Kerala, India

[3]Associate Professor, Dept. of Anatomy, Jawaharlal Nehru Medical College, DattaMeghe Institute of Medical Sciences (DMIMS), Sawangi (Meghe), Wardha, India

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Corresponding Author:

Dr.VaibhavAnjankar, Associate Professor, Dept. of Anatomy, Jawaharlal Nehru Medical College, DattaMeghe Institute of Medical Sciences (DMIMS), Sawangi (Meghe), Wardha, India; Email ID: vaibhav_anjankar@yahoo.co.in

ABSTRACT: Background:Formaldehyde is extensively used in Department of Anatomy for preservation of biological specimens as well as cadavers. Formaldehyde being a noxious chemical may cause respiratory health problems among 1st year medical students.

Objective:The following study was planned to observe the effect of formaldehyde vapours on respiratory parameters – FVC, FEV1 and FEV1% of 1st year MBBS students who are routinely exposed to formalin vapours.

Methodology:Randomly selected fifty medical students [Mean (SD) age of 18.94 (0.65) years] were assessed within 1week of admission to college and re-examined at intervals of 1 month and 6 months. Similarly fifty nursing and para-medical students who were not exposed to formaldehyde were selected and readings were taken at same intervals. Data was entered in Microsoft Excel and was analysed using Epi Info software version 7.

Results:There was a decrease in FVC and FEV1. There was an increase in FEV1% values (on comparing values after 6 months with that of baseline values) in MBBS students on comparing with para-medical students.

Keywords – Formaldehyde, FVC**,** Spirometry, Embalming and FEV1%.

INTRODUCTION

Formalin solution contains 40% by volume or 37% by weight formaldehyde gas in water[1]. Formaldehyde being highly volatile and irritative in nature causes various adverse effects. Acute adverse effects includes irritation and watering of eyes, nose and throat, in susceptible individuals causes laryngitis, asthmatic attacks and bronchitis[2]. Squamous cell carcinoma of nasal respiratory epithelium in rats and mice are also seen. Because of toxic

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effect of formaldehyde several European countries have restricted the use of formaldehyde (including the import of formaldehyde treated products and embalming) [3].

But in India we still use formaldehyde extensively in medical profession for purposes like embalming, external tissue fixation. Thereby exposing medical professionals to this chemical. In MBBS curriculum much time in anatomy is given to dissection with equal exposure to all students. Uchiyama Iet al, Chia SE et al,Schachter EN et al, Sheppard D et al and Uba G et al recommended that exposure concentration of formaldehyde to medical students should be limited because of its irritant, sensitizing potential and carcinogenic effects[4, 5, 6, 7, 8].

Pulmonary function test provides important clinical informations. These are designed to identify and quantify defects and abnormalities in function of respiratory system. Ventilatoryfunction test assess the expansion of lungs and chest wall. This is accomplished by measurement of various lung volumes and capacities. Spirometry is the method used for measuring various lung functions. Spirometry refers to recording volume changes during various clearly defined breathing manoeuvres. It can be done using simple spirometer or computerized spirometer. For various study purposes computerized spirometer is used[9].

So in this study we aim to compare the effect of formaldehyde vapours in pulmonary functioning (Spirometry) among medical students.

MATERIALS AND METHODS:

Pulmonary function test (spirometry) performed and FVC, FEV_1 and $FEV_{1\%}$were measured. It was done using portable electronic spirometer (MIR Spirobank II Spirometer). Study was started after obtaining clearance from Institute Ethical Committee.

Sample size calculation:

The sample size was calculated based on study by Shrivastava A and SaxenaY[10](2013) using the formula

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2(\sigma_1^2 + \sigma_2^2)}{L^2}$$

Here $Z\alpha/2 = 1.96$; $Z\beta = 0.84$; L = mean1 – mean2 = 3.41 – 2.94; $\sigma1 = 0.87$; $\sigma2 = 0.8$.

With a power of study of 90% and significance level of 5%, the sample size was calculated to be 100(includes 50 exposed subjects and 50 non-exposed subjects)

Study participants included 50 MBBS students (study group) and corresponding 50 first year nursing and para-medical students (control group) in Government Medical College, Thrissur. Informed consent was taken from all the participants.Procedure was explained and demonstrated to participants.

PFT variables – FVC, $FEV_1$and $FEV_{1\%}$ taken. Data were collected on three occasions –

1. First reading was taken before MBBS students were taken to dissection hall (pre-exposure)

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2. Second and third readings were taken after 1 month and 6 months of dissection (post-exposure). 2nd reading for acute effect; 3rd reading after 6 months for chronic effect.
3. Simultaneous readings were taken for nursing and para-medical students

Inclusion criteria

- Age between 17 to 20 yrs.
- Non-smokers
- Non tobacco chewing

Exclusion criteria

- History of chronic respiratory disease or cardiac disease
- History of previous exposure to formalin
- History of previous abnormal spirometry findings

Data was entered in MS Excel and was analysed using software Epi Info software version 7.Independent‘t’ test and paired‘t’ test was used and p-value <0.05 was taken as significant.

RESULTS:

Table 1: Anthropometric measurements among MBBS students and Paramedical Students

	MBBS students n=50 (mean ± SD)	Paramedical students n=50 (mean ± SD)	Mean difference	p-value
Age (years)	18.9±0.6	18.9±0.6	-	1
Height (cm)	166.96±9.8	165.74±9.8	1.22	0.469
Weight (kg)	61.5±13.2	57.22±8.3	4.28	0.057

Table 2: Mean values of FVC, FEV1 and FEV1% from three readings in MBBS and Paramedical students

Parameters	Parameters in first, second and third reading respectively	MBBS students n=50 (mean ± SD)	Paramedical students n=50 (mean ± SD)
FVC	FVC(1)	3.54 ± 0.6	3.55 ± 0.7
	FVC(2)	3.35 ± 0.9	3.53 ± 0.7
	FVC(3)	2.91 ± 0.9	3.55 ± 0.7
FEV1	FEV1(1)	3.02 ± 0.6	3.13 ± 0.6

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	FEV1(2)	2.96 ± 0.7	3.12 ± 0.7
	FEV1(3)	2.67 ± 0.8	3.13 ± 0.7
FEV1%	FEV1%(1)	85.16 ± 6.4	88.66 ± 4.8
	FEV1%(2)	89.14 ± 6.4	88.26 ± 5.0
	FEV1%(3)	91.64 ± 4.8	88.15 ± 5.06

FVC(1)→ FVC in 1st reading;
FVC(2)→ FVC in 2nd reading;
FVC(3)→ FVC in 3rd reading
FEV1(1) → FEV1 in 1st reading;
FEV1(2) → FEV1 in 2nd reading;
FEV1(3) → FEV1 in 3rd reading
FEV1%(1) → FEV1% in 1st reading;
FEV1%(2) → FEV1% in 2nd reading;
FEV1%(3) → FEV1% in 3rd reading

To analyse the effect of formaldehyde exposure over a period of 6 months, the difference in the values of FVC (1) and FVC (3), FEV1(1) and FEV1(3)&FEV1% (1) and FEV1% (3) was calculated in both groups of participants. Then these difference in values of both groups were compared to analyse for any significance.

Table 3: Comparing the difference in FVC, FEV1 and FEV1% values in baseline reading and after 6 months among the two groups

	Mean*	SD	t-value	Df	p-value
FVC E	0.63	0.4	8.45	98	<0.001
FVC NE	-0.0016	0.2			
FEV1 E	0.34	0.4	4.89	98	<0.001
FEV1 NE	0.0062	0.2			
FEV1%E	-6.48	7.6	-5.425	98	<0.001
FEV1%NE	0.51	4.99			

*Mean is difference in baseline value and value after 6 months exposure
FVC E → mean FVC(1) – mean FVC(3) of exposed group students
FVC NE → mean FVC(1) – mean FVC(3) of non-exposed group students
FEV1 E → mean FEV1(1) – mean FEV1(3) of exposed group students
FEV1 NE → mean FEV1(1) – mean FEV1(3) of non-exposed group students
FEV1%E →mean FEV1%(1) – mean FEV1%(3) of exposed group of students
FEV1%NE →mean FEV1%(1) – mean FEV1%(3) of non-exposed group of students

DISCUSSION:

Analysing the difference in mean baseline value and mean value after 6 months of exposure for FVC (i.e. FVC E and FVC NE) in Table 3, there was a significant difference in the third reading i.e. there was a statistically significant decrease in FVC reading in exposed group of students when compared to non-exposed group of students. Similarly in table 3, difference in baseline mean FEV1 value and mean value after 6 months of exposure showed

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statistically significant decline in values of MBBS students when compared to the para-medical students who were not exposed to formalin (FEV1 E and FEV1 NE).On analysing the mean FEV1% values (FEV1%E and FEV1%NE) in Table 2, there was a statistically significant increase of its value in MBBS students on comparing with para-medical students.

Akbar-Khanzadeh F and Mlynek J S studied the changes in respiratory function within one hour and three hour exposure to formaldehyde in 50 medical students and compared the results with 36 non-exposed physiotherapy students. They concluded that variables (FVC and FEV1)of respiratory function were increased in both groups for the one hour and three hour readings. This increase was said to be due to diurnal variation. But the increase in the exposed group of students was less as compared to non-exposed group of students[11].

Kilburn K H and co-workers studied the effect of chronic low dose exposure of formaldehyde on pulmonary function in histology technicians for five years and compared their values with women from Michigan who were not exposed to formaldehyde. There was a steeper decrement in vital capacity and flows among the histology technicians compared to the women from Michigan [12].

Neghab M and co-workers studied the effect of chronic exposure to melamine-formaldehyde resin among 70 workers and compared it with 24 non-exposed employees. Their study showed that there was an acute partial reversible effect but long term exposure resulted in significant irreversible decrement in VC, FVC and FEV1[13].

Alexanderson R and Hedenstierna G studied the effect of occupational exposure of formaldehyde on pulmonary function among 47 wood workers and compared it with 20 controls (non-exposed) subjects. They found that there was a transient decrease in the mid expiratory flow (FEF25-75%) and FEV1% among exposed wood workers when compared with non-exposed control group. This decrease reverted back to normal following a non-exposure period of 4 weeks [14].

In our study, there was a decrease in FVC and FEV1 values but there was an increase in the FEV1% values in MBBS students as compared to para-medical students from table 3. This may be because of involvement of lung interstitium. As documented in studies by Turkoglu AO et al[15] and Odinko CD et al[16], involvement of lung interstitium could be related to the cause of such a pattern. The exact mechanism of this process is not known. But as suggested by Shrivastava A et al[10] formaldehyde binding to endogenous proteins creates hapten that can elicit an immune response. TurkogluA O et al[14] in their study said that formaldehyde reacts directly with tissue constituents and cytotoxicity was presumably a function of this reactivity. Formaldehyde has oxidant effects and it decreases Superoxide Dismutase (SOD) activity and increases Malondialdehyde (MDA) levels that are indicative of oxidative damage caused by formaldehyde.

CONCLUSION

Mean FVC & FEV1 values showed a decrease while FEV1% value showed an increase in the final reading (though it was clinically not significant). Formalin has an adverse effect on respiratory system over a period of six months.Measures should be taken to reduce the deleterious effects of formaldehyde among exposed individuals.

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