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The effects of passive smoking on COHb, PaO_2 and $PaCO_2$ levels and postoperative respiratory complications in children undergoing general anesthesia

Ayşe Çiğdem Tütüncü, Özlem Korkmaz Dilmen, Tuğhan Utku, Emre Erbabacan, Birsel Ekici, Güniz Köksal, Fatiş Altıntaş, Güner Kaya

İstanbul University Cerrahpaşa Medical Faculty, Department of Anesthesiology and Reanimation, İstanbul, Turkey

Summary

Aim: Exposure to passive smoking is associated with side effects on pulmonary function in children and also a risk factor for adverse outcomes following anesthesia and surgery. The objective of this study was to determine the effect of passive smoking on COHb, arterial oxygen pressure (PaO_2) and arterial carbon dioxide pressure ($PaCO_2$) levels and on postoperative adverse respiratory events in children undergoing general anesthesia.

Material and Method: One hundred children (1-16 y) undergoing urologic or abdominal surgery with a history of passive smoking from one or both parents and 50 children with no history of exposure to smoking were analyzed for COHb, PaO_2 and $PaCO_2$ levels during the anesthesia and for postoperative respiratory events. Parents were asked to complete a questionnaire about their smoking habits before surgery. The arterial blood samples were obtained after intubation of the patients. The respiratory symptoms were evaluated during the stay in the recovery room. The study was approved by the ethics committee (2.06.2009-18442).

Results: COHb levels were increased significantly in both one parent smoking group (Group E1) 1.306±0.452 % and two parents smoking group 1.396±0.491% (Group E2). Children with no smoking parents (Group H) had significantly lower COHb levels (1.134±0.491%) compared to the other two groups (p=0.011). The lowest $PaCO_2$ levels were detected in Group H (33.234±4.33 mmHg) which were significantly lower compared to the other two groups (p=0.007). The number of children with asthma was higher in Group E2 (18%) (p=0.006). There was no significant difference between the groups in terms of PaO_2 levels and postoperative respiratory side effects. Bronchial hypersecretion, cough and desaturation were the most common side effects.

Conclusions: Our results indicate that children who are passive smokers should be undergone careful preoperative evaluation considering other coexisting risk factors to avoid postoperative complications. *(Turk Arch Ped 2012; 47: 202-207)*

Key words: Anesthesia, carboxyhemoglobin, complication, children, passive smoking

Introduction

The levels of cotidin and carbon monoxide (CO) which are the toxins and metabolites of nicotine contained in cigarette are found in blood and expirium air depending on cigarette consumption. Carbon monoxide binds to hemoglobin in blood and forms carboxyhemoglobin (COHb). While this value is <1% in non-smokers, it is found to be >4% in active smokers. In addition, a marked increase in COHb values has been observed in a passive smoker adult patient group compared to non-smokers (1).

Parents who are smokers have reported some negativities arising from passive smoking starting from the fetal period. Frequent lung and middle ear infections as a result of inhibition of mucociliary activity and immune system are some of these negativities. In addition, it has been found that the rates of airway hyperreactivity and asthma are high in these children. All these can increase the risk of respiratory complications in the post-operative period especially in children who will undergo general anesthesia (2,3).

In this study, it was planned to compare COHb, PaO2, PaCO2 levels and postoperative anesthesia complications between children aged 1-16 years who are passive smokers and who have non-smoker parents planned to be operated in Cerrahpaşa Medical Faculty, Pediatric Suregery Clinic.

Material and Method

Following the approval of the hospital ethics committe on 06.02.2009 with the number 18442 patients aged 1 and 15

Address for Correspondence: Ayşe Çiğdem Tütüncü MD, İstanbul University Cerrahpaşa Medical Faculty, Department of Anesthesiology and Reanimation, İstanbul, Turkey
Phone: +90 212 414 300/225 74 Fax: +90 212 414 32 69 E-mail: acyardimci@yahoo.com **Received:** 05.10.2011 **Accepted:** 25.10.2011

years who would undergone lower abdominal and urologic surgery (ASA I-II) in the operation room of Cerrahpaşa Medical Faculty Pediatric Surgery between June 2009 and 2010 were included in the study. The parents of the patients were asked to complete a questionnaire form including the topic of smoking. 150 patients were included in the study in accordance with the information obtained from parent forms. The patients were divided into three groups as follows: Group H (n=50): none of the parents was smoker, Group E1 (n:50): one of the parents was smoker, Group E2 (n:50): both parents were smokers.

Patients whose parents smoked for less than three years, had a cigarette consumption of <10 and who had undergone surgery before were not included in the study. In addition, urgent surgical interventions, head and neck surgery and large operations lasting longer than 3 hours were not included in the study, either (Table 1).

All patients were evaluated preoperatively and appropriateness for anesthesia was confirmed. In the operation room, monitoring included ECG, SpO_2, $ETCO_2$ and invasive arterial pressure. Following inhalation or intravenous induction the patients were intubated and pressure controlled ventilation was performed. For anesthesia maintenance 2-3% sevoflurane and a mixture of 40% oxygen and 60% air were used. Blood gases were measured in the period following intubation just after mechanical ventilation started. Patients who were extubated after surgical procedure were followed up in the recovery room for two hours in terms of laryngospasm, bronchospasm, increase in bronchial secretions, desaturation, cough and other possible complications. The anesthesist and recovery room nurse were informed about form information and which patients would be included in the study.

The data obtained in the study were analysed using SPSS (Statistical Package for Social Sciences) for Windows 17.0 program. To determine the difference between groups non-parametric tests including Kruskal Wallis H-Test, Mann Whitney U test and chi-square test were used. The results obtained were interpreted with a 95% confidence interval at a level of significance of 0.05 ($p<0.05$).

Results

Mean ages of the parents and the patients included in the study: the mean age of the mothers was found to be 34.52±7.94 in Group H, 32.38±7.013 in Group E1 and 31.96±6.47 in Group E2. The mean age of the fathers was found to be 38.04±7.58 in Group H, 36.4±7.93 in Group E1 and 35.78±6.8 in Group E2. The mean age of the children was found to be 84.73±60.59 months in Group H, 87.58±68.343 months in Group E1 and 97.48±77.7 months in Group E2. No statisitcally significant difference was found between the three groups in terms of mean ages ($p>0.05$) (Table 1).

COHb values were found to be 1.134±0.49% in Group H, 1,306±0,452% in Group E1 and 1.396±0.496% in Group E2. A statistically significant difference was found between Group H and Group E1 and E2 ($p=0.011$). No significant difference was found between Group E1 and Group E2 in terms of COHb values (Table 2, Graphic 1).

Form 1. Form sample given to parents who smoked

Complications which occured during and after general anesthesia in children whose parents smoked

Age of mother **Age of father** **Age of child**

Questions asked to mothers

1. Are you a smoker ?
Yes ( ) No ( )

2. How many cigarettes do you smoke per day?
3-5 ( ) 5-10 ( ) 10-20 ( ) More than 20 ( )

3. For how many years have you been smoking?
1-3 ( ) 3-5 ( ) 5-10 ( ) More than 10 years ( )

4. Did you smoke while you were pregnant?
Yes ( ) No ( )

5. Did you smoke while you were breastfeeding?
Yes ( ) No ( )

6. Has your child had throat infection (upper respiratory tract infection) in the last one year? How many times?
None ( ) 1-3 times ( ) 3-5 times ( ) 5-10 times ( ) more than 10 times ( )

8. Does your child have asthma?
Yes ( ) No ( )

Questions asked to fathers

1. Are you a smoker?
Yes ( ) No( )

2. How many cigarettes do you smoke per day?
3-5 ( ) 5-10 ( ) 10-20 ( ) More ( )

3. For how many years have you been smoking?
1-3 ( ) 3-5 ( ) 5-10 ( ) Longer ( )

Postoperative complications
Bronchospasm
Desaturation
Laryngospasm
Cough
Other

PCO_2 ***COHb*** ***PO_2***

This study has been designed to investigate the relation of passive smoking with respiratory complications during or after surgery in children whose parents are smokers.

The data obtained from the questionnaire will be used for scientific research. Your identity information will be kept hidden and will not be used.

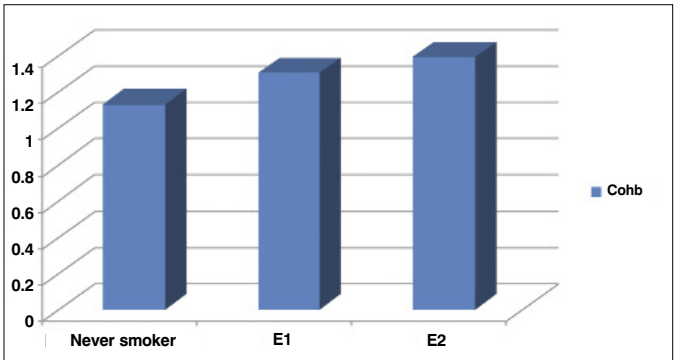
PaO_2 value was found to be 169.51±46.64 mmHg in Group H, 167.64±43.41 mmHg in Group E1 and 162.48±43.91 mmHg in Group E2. No statistically significant difference was found between the groups in terms of PaO_2 values (p=0.442) (Graphic 2).

A statistically significant difference was found between the groups in terms of PCO_2 values (p=0.007). $PaCO_2$ value in Group E2 (35.8±3.62 mmHg) was found to be significantly higher compared to group E1 (34.16±4.53 mmHg) and Group H (33.2±4.3) (p=0,002). There was also a statistically significant difference between Group E2 and Group E1 (p=0.039) (Table 2, Graphic 3, Graphic 4).

While the number of children with asthma was found to be 9 (18%) in Group E2, it was found to be 2 (4%) in Group E1 and 1 (2%) in Group H. The rate of asthma was significantly higher in group E2 compared to the other two groups (p=0,006) (Table 5). No difference was found between Group E1, E2 and H in terms of the frequency of side effects (Table 5).

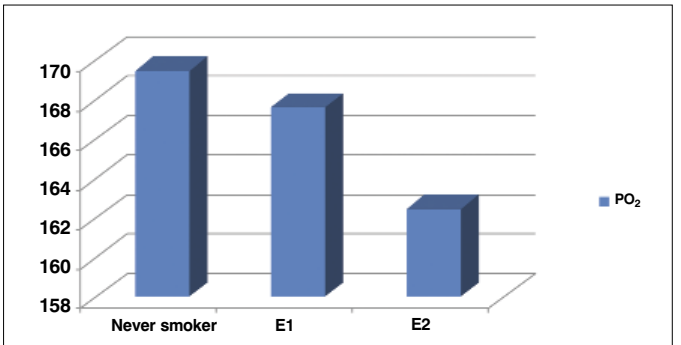
The most common complications in all three groups included increase in bronchial secretions, cough, desaturation, laryngospasm and bronchospasm in order. In some patients and especially in Group E1 and E2, multiple side effects were observed in the same patient (Table 6). When COHb and $PaCO_2$ values and the frequency of side effects were compared, no difference was found between the groups (Table 3, Table 4).

The highest number of mothers who smoked during pregnancy and breastfeeding was found in Group E2. While the number of mothers who smoked during pregnancy was 24 in Group E2, it was 1 in Group E1. The number of mothers who smoked during breastfeeding was found to be 14 in Group E2 and 4 in Group E1 (Table 7).



A significant difference was found between Group H and Group E1 and E2 in terms of COHb values
No statistically significant difference was found between Group E1 and Group E2.

Graphic 1. Comparison of COHb values of the groups



No statistically significant difference was found between the groups in terms of PO2 values

Grafik 2. Grupları PO_2 değerlerinin karşılaştırılması

Table 1. Demographic data

	Grup H	Grup E1	Grup E2	p
Age of child (months)	M:18 F:32 84.73±60.59	M:24 F:26 87.58±68.343	M:21 F:29 97.48±77.7	0.812
Age of mother (years)	34.52±7.94	32.38±7.013	31.96±6.47	0.257
Age of father (years)	38.04±7.58	36.4±7.93	35.78±6.8	0.258

No difference was found between the groups in terms of age of child, age of mother and age of father

Table 2. Comparison of COHb, PO_2, CO_2 between the groups

	Group H	Group E1	Group E2	p
COHb (%)	1.134±0.491	1.306±0.452	1.396±0.491	0.011
PO_2 (mmHg)	169.518±46.646	167.640±43.419	162.488±43.919	0.442
PCO_2 (mmHg)	33.234±4.331	34.162±4.532	35.8±3.620	0.007

A statistically significant difference was found between Group H and Group E1 and E2 in terms of COHb values
No statistically significant difference was found between Group E1 and Group E2 in terms of COHb values
No statistically significant difference was found between the groups in terms of PO_2 values
A statistically significant difference was found between group H and Group E1 and E2 and between Group E1 and Group E2

Discussion

Carbon monoxide is formed as a result of burning of products containing carbon including tobacco, passes the capillary membrane by inhalation, binds with hemoglobin in pulmonary capillary blood and carboxyhemoglobin (COHb) is formed. It is thought that CO value measured in expirium air and COHb value measured simultaneously in blood gases are indicators of CO production namely cigarette consumption (3,4). In the study performed by Deveci et al. (5) in which end-expiratory CO values were compared between non-smokers, active smokers and passive smokers, the values were found to be 3.61±2.15 ppm, 17.13±8.5 ppm and 5.2±3.38 ppm, respectively. It has been found that pulmonary mechanics is affected and the frequency of hyperreactive airway and tendency to infections are increased in children exposed to passive smoking. In addition, COHb values have been found to be higher in these children compared to

Table 3. Comparison of COHb values and side effects between the groups

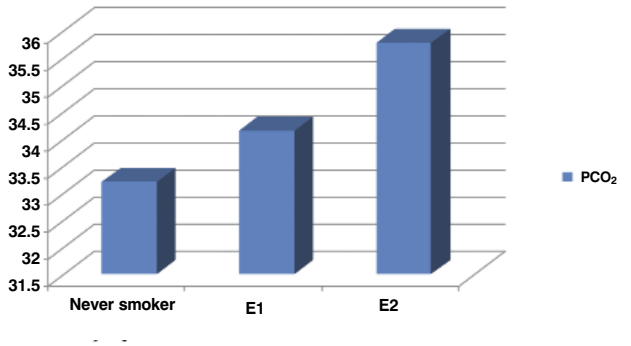
COHb (%)	Side effect -	Side effect +	p
Group H	1.163±0.512	1.042±0.42	0.460
Group E1	1.358±0.486	1.142±0.278	0.151
Group E2	1.409±0.465	1.369±0.557	0.791

No statistically significant difference was found between the groups in terms of COHb values

Table 4. Comparison of PCO_2 values and side effects between the groups

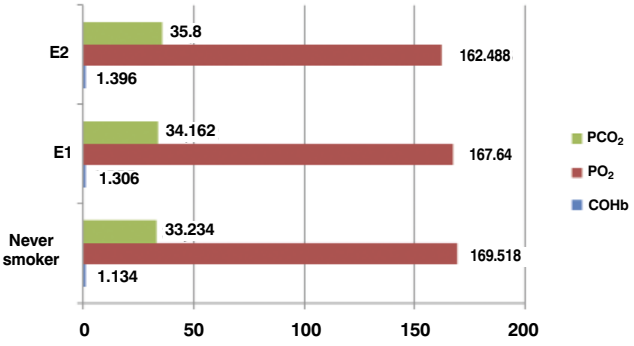
PCO_2 (mmHg)	Side effect (-)	Side effect (+)	p
Group H	33.55±4.66	32.23±2.98	0.364
Group E1	34.4±5	33.4±2.47	0.514
Group E2	35.57±3	36.27±4.65	0.59

No statistically significant difference was found between the groups in terms of PCO_2 values and the frequency of side effects



A statistically significant difference was found between Group H and Group E1 and E2 and between Group E1 and Group E2 in terms of PCO_2

Graphic 3. Comparison of PCO_2 values of the groups



A statistically significant difference was found between Group H and Group E1 and E2 in terms of COHb values
No statistically significant difference was found between Group E1 and Group E2 in terms of COHb values
No statistically significant difference was found between the groups in terms of PO_2 values
A statistically significant difference was found between Group H and Group E1 and E2 and between Group E1 and Group E2

Graphic 4. Comparison of PCO_2, PO_2 and COHb between the groups

Table 5. Comparison of side effects, infection and asthma between the groups

		Group H (n)	Group E1 (n)	Group E2 (n)	p
Asthma	(+) (-)	1 (2%) 49 (98%)	2 (4%) 48 (96%)	9 (18%) 41 (82%)	**0.006**
Infection	(+) (-)	13 (26%) 37 (74%)	18 (36%) 32 (64%)	18 (36%) 32 (64%)	0.469
Side effect	(+) (-)	12 (24%) 38 (76%)	12 (24%) 38 (76%)	16 (32) 34 (68%)	0.580

The frequency of asthma was found to be statistically significantly higher in Group E2 compared to Group E1 and Group H
No significant difference was found between the groups in terms of the frequency of infection
No significant difference was found between the groups in terms of the frequency of side effects

Table 6. Distribution of side effects in the groups

Side effect	Group H (n)	Group E1 (n)	Group E2 (n)
Hypersecretion	4	8	10
Cough	4	7	6
Desaturation	6	6	7
Laryngospasm	2	2	4
Bronchospasm	-	1	2

Table 7. Distribution of mothers who smoked during pregnancy and breastfeeding in the groups

	Group H (n)	Group E1 (n)	Group E2 (n)
Smoking during pregnancy (+)	n=0 (0%)	n=1(2%)	n=24 (48%)
Smoking during pregnancy (-)	n=50 (100%)	n=49 (98%)	n=26 (52%)
Smoking during breastfeeding (+)	n=0 (0%)	n=4 (8%)	n=14 (72%)
Smoking during breastfeeding (-)	n=50 (100%)	n=46 (92%)	n=36 (28%)

children who have non-smoking parents (2,6). In the study performed by Branden et al. (3) in 250 children aged 1-12 years, COHb values were measured non-invasively in the preoperative period and were found to be higher in children who had smoking parents compared to children who had non-smoking parents.

In this study, COHb levels were found to be higher in children who were being exposed to passive smoking compared to children who had non-smoker parents. No significant difference was found between the group who had one smoker parent and the group who had two smoker parents. This result suggests that presence of cigarette and its products in the environment absolutely affects the child. It was emphasized that COHb levels varied by exposure time and amount in passive smokers. It was stated that COHb level increased by 1-6% following one hour of exposure to smoking, CO level increased up to 20 ppm when the exposure time was two hours and this value was equivalent to active smoking (7). The fact that the parents included in our study had been smoking for at least three years and more than 10 cigarettes per day suggested that adequate amount and time were fullfilled to affect the children. In the study performed by Ece et al. (8) in healthy children and children with asthma who were passive smokers, no difference was found between the group with one smoker parent and the group with two smoker parents in terms of CO values in expirium air. The fact that there was no difference between the two groups who smoked was attributed to the behaviour patterns developed by the parents to protect the child for whom surgery was planned and to decrease possible problems which might arise in the group who smoked more. In the study performed by Shi et al. (9), it was found that the parents of the children who were undegone surgery attempted to quit smoking at least for one time during the first year after surgery.

In our study, no relation was found between COHb values and rates of side effects in the groups. This was attributed to the fact that the patients were taken to surgery in the best state and condition possible to decrease the possibility of complication. In addition, it was also thought that complications were decreased because of precautions taken by the parents for protection for their children for whom elective surgery was planned. When the numbers of total patients in whom side effects were observed were compared, no significant difference was found between the groups. However, multiple side effects were observed frequently in groups who smoked and especially in children whose both parents smoked. When the most common side effects were compared, it was found that increase in bronchial secretions and cough were observed more frequently in children whose parents were smokers compared to children whose parents were non-smokers. This suggested that the effect of smoking to increase mucus secretion and damage ciliary activity was as efficient in passive smokers as in active smokers. Studies showed a proportional relation between cotidin and COHb levels which are biologic markers of the amount of cigarette smoked daily and the frequency of complications in the postoperative period in children who were passive smokers (10,11). Smoking cause narrowing in small airways and increase in closure volumes with damage in the bronchial epithelium, increase in permeability and loss of surfactant (10). The fact that desaturation and bronchospasm were found in more patients in the group who smoked suggested that the above-mentioned pathological variables were effective in children who were passive smokers. Similarly, the rate of asthma was found to be significantly higher in Group E2 compared to the other groups in our study. In chronic smokers, “obstructive” changes were found in lung function tests, whereas lung function tests could be normal in smokers with no findings, but their closure volumes were found to be increased (6,11). In the study performed by Manino et al.(11) in 5400 children aged 4-16 years in which cotidin levels and level of passive smoking were examined, it was found that the frequency of asthma was higher in children with high cotidin levels and FEV1/FVC ratio was found to be below 0.8 in the group with the highest cotidin level. It was reported that passive smoking increased the signs of pre-existing asthma,

was an important factor affecting lung functions negatively and findings were more prominent in the group who continued to smoke during pregnancy (12,13). In our study, the rate of smoking during pregnancy was found to be 48% in Group E2 in which the rate of asthma was found to be significantly higher. It was found that passive smoking affected lung functions negatively and especially reduced FEV1, FEV1\FVC, MEFR values (14). In our study, lung function tests were not performed in the children, but the high rate of asthma in Group E2 and significantly increased PaCO2 values in Group E1 and E2 were thought to be indirect indicators of obstruction. Laryngospasm and bronchospasm were observed with a lower rate in the study. In studies performed, most children in whom bronchospasm was observed after surgery were found to have atopy and asthma (15). In our study, it was observed that the rate of bronchospasm was considerably low by comparison with the number of patients with asthma. It was thought that the best conditions possible were ensured during the preperation period before anesthesia for these patients. Many factors including anesthesia method, age, neuromuscular blocker use, airway hyperreactivity, presence of upper respiratory tract infection and passive smoking are thought to be involved in occurence of laryngospasm after surgery (16).

The study was planned considering the statements of the parents. There is a possibility that some parents might have not reflected the reality fully in order to protect themselves. Therefore, we believe that studies including higher number of patients with simultaneous measurement of cotidin or COHb values in the parents and children would affect the results.

In our study, COHb levels in children who were passive smokers were found to be higher compared to the group who did not smoke. Although no difference was found in terms of complications which occured during anesthasia, the frequency of asthma was found to be higher especially in the group in which both parents were smokers and PCO_2 values were found to be higher in the groups who smoked compared to the group who never smoked. This suggested that parental smoking affected the lung functions of the children negatively. Conclusively, children who are passive smokers should be evaluated carefully to avoid postoperative complications considering other risk factors preexisting before surgery.

Conflict of interest: None declared.

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