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Research

The Effect of Parental Smoking Exposure on Perioperative Respiratory Complications in Children

Çocuklarda Ebeveynlerin Sigara Dumanına Maruz Kalmanın Perioperatif Solunumsal Komplikasyonlara Etkisi

Sezgin Bilgin[1], Cengiz Kaya[1], Burhan Dost[1], Esra Turunç[1], Gökçe Eraydın[1], Özlem Terzi[2], Sibel Barış[1]

[1]Ondokuz Mayıs University Faculty of Medicine, Department of Anesthesiology and Reanimation, Samsun, Türkiye
[2]Ondokuz Mayıs University Faculty of Medicine, Department of Public Health, Samsun, Türkiye

ABSTRACT

Objective: To determine the effect of parental smoking (PS) exposure on the incidence of respiratory complications in children who received general anesthesia.

Methods: This study was conducted at a university hospital between April and October 2022. A total of 98 children aged 0-16 years who had an American Society of Anesthesiologists Physical Status score of 1-2 and underwent general anesthesia were included in the study. The children were divided into two groups: PS and non-PS groups. Parents were asked to provide basic demographic information about their children, such as age, sex, and medical conditions (presence of an allergy, history of surgery, and diagnosed diseases) as well as their household tobacco consumption. Respiratory complications (desaturation SpO_2 <92%, bronchospasm, laryngospasm, increased airway secretion, cough, breath-holding spells lasting longer than 15 seconds, wheezing, and croup) were recorded before induction, during the intraoperative period, after extubation, and in the post-anesthesia care unit.

Results: Our study indicated that the incidence of complications was significantly higher in children exposed to PS than in those who were not (35.7% and 16.7%, respectively; p=0.03). Most of the complications occurred following extubation, and the common complications were laryngospasm, increased airway secretion, and breath-holding spells. No statistically significant difference in the development of complications was observed based on the sex of the child, exposure time, duration and type of surgery, airway management technique, and number of cigarettes consumed by the parents. The incidence of complications increased as the distance of cigarette exposure decreased (p=0.03).

Conclusion: PS exposure increased the incidence of respiratory complications in children undergoing general anesthesia, and the frequency of complications increased as the distance of exposure decreased.

Keywords: Children, general anesthesia, smoke exposure, respiratory complication

ÖZ

Amaç: Pasif içiciliğe (PS) maruz kalan çocuklarda özellikle laringospazm, bronkospazm ve öksürük gibi perioperatif solunum komplikasyonları riski daha yüksektir. Çocuklar ebeveynleriyle önemli miktarda zaman geçirirler ve eğer ebeveynleri sigara içiyorsa bu onların birincil maruziyet kaynağı olabilir. Çalışmamızda genel anestezi uygulanan çocuklarda ebeveyn sigara maruziyetine bağlı solunum sistemi komplikasyonlarının görülme sıklığının belirlenmesi amaçlandı.

Metod: Bu çalışma, Nisan ve Ekim 2022 tarihleri arasında bir üniversite hastanesinde gerçekleştirildi. Çalışmaya genel anestezi uygulanan, Amerikan Anestezi Derneği Fizik Durumu skoru 1-2 olan, 0-16 yaş arası toplam 98 çocuk dahil edildi. Çocuklar PS grubu ve non-PS grubu olmak üzere iki gruba ayrıldı. Ebeveynlerden çocukları hakkında bazı temel demografik bilgiler vermeleri istendi: Yaş, cinsiyet ve tıbbi durumlar (alerji varlığı, ameliyat öyküsü ve teşhis edilmiş hastalıklar) ve evdeki tütün tüketimi. İndüksiyon öncesi, intraoperatif dönemde, ekstübasyon sonrası ve anestezi sonrası bakım ünitesinde, solunum sistemi komplikasyonları (desatürasyon SpO_2 <%92, bronkospazm, laringospazm, artmış hava yolu sekresyonu, öksürük, 15 saniyeden uzun süren nefes tutma, hırıltı ve krup) kaydedildi.

Bulgular: Çalışmamız, komplikasyon insidansının ebeveyn sigara dumanına maruz kalanlarda kalmayanlara göre istatistiksel olarak anlamlı derecede yüksek olduğunu gösterdi (sırasıyla %35,7 ve %16,7; p=0,03). Komplikasyonların çoğu ekstübasyonu takiben meydana geldi ve yaygın

Address for Correspondence: Sezgin Bilgin, Ondokuz Mayıs University Faculty of Medicine, Department of Anesthesiology and Reanimation, Samsun, Türkiye
Phone: +90 362 312 19 19 (2707) E-mail: sezgin.bilgin@omu.edu.tr ORCID ID: orcid.org/0000-0002-3031-8488

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komplikasyonlar laringospazm, artan hava yolu sekresyonu ve nefes tutma olarak bulundu. Çocuğun cinsiyeti, maruz kalma süresi, ameliyat süresi ve tipi, hava yolu yönetimi tekniği ve ebeveynlerinin içtiği sigara sayısına göre komplikasyon gelişmesinde istatistiksel olarak anlamlı bir fark yoktu. Dumana olan mesafe azaldıkça komplikasyon insidansı arttı (p=0,03).

Sonuç: Çalışmamızda ebeveynlerin sigara dumanına maruziyet, genel anestezi uygulanan çocuklarda solunum sistemi komplikasyonlarının insidansını artırdı ve maruz kalma mesafesi kısaldıkça komplikasyon sıklığını daha da artırmaktadır.

Anahtar Kelimeler: Çocuklar, genel anestezi, pasif duman maruziyeti, solunumsal komplikasyonlar

INTRODUCTION

Despite significant global struggles, tobacco consumption seems to be a ubiquitous addiction (1). Second-hand smoking, also known as passive smoking, occurs when people who do not smoke inhale tobacco smoke. Smokers breathe in air containing more than 4,000 chemical compounds, many of which are hazardous and/or carcinogenic (1,2). Exposure to tobacco smoke residues on the surfaces of goods is known as third-hand smoking (3). Toxic substances can linger for a long time on skin, hair, clothes, or furniture (4). Therefore, contact with harmful chemicals is possible even without direct inhalation of cigarette smoke. Children are more vulnerable and sensitive to second- and third-hand smoking exposure than adults because their immune systems are still immature, their airways are narrower, their breathing rates are higher, and they display more hand-to-mouth contact behavior. They also spend a significant amount of time with their parents, which could be a source of exposure if their parents smoke. Children whose parents smoke are exposed to passive smoking nine times more than children from non-smoking families (3,5).

Environmental tobacco smoke exposure is a major preventable risk factor for a child's overall health. Passive smoking increases the incidence of sudden infant death syndrome, lower respiratory tract infections, severe and frequent asthma attacks, ear infections, and meningitis in children (6). Furthermore, children exposed to passive smoking have a higher risk of perioperative respiratory complications, particularly laryngospasm, bronchospasm, and cough (7). Our study aimed to determine the effect of cigarette smoke exposure on the incidence of respiratory complications in children who received general anesthesia. Furthermore, the frequency of complications was evaluated in relation to the number of parents who smoked, exposure distance, airway management technique, and daily cigarette consumption.

METHODS

This was a single-center prospective cross-sectional study and was approved by the Ondokuz Mayıs University Clinical Researches Ethics Committee (decision no: OMÜ KAEK 2022/103, date: 15.03.2022). Written informed consent was obtained from all parents before their children enrollment in the study. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Study Population

The data for this study was obtained through patient-reported paper surveys distributed between April and October 2022 to the parents of children aged 0-16 years. All patients with an American Society of Anesthesiologists Physical Status score of 1-2 who underwent general anesthesia were included in the study. The exclusion criteria were as follows: (i) Patients with a known history of lung disease (asthma, bronchitis, etc.) and cardiothoracic and neurosurgical procedures, (ii) a recent history of upper (<4 weeks) or lower respiratory tract infections (<6 weeks), (iii) a recent history of coronavirus disease-2019 (<4 weeks for asymptomatic patients and <6 weeks for symptomatic patients), (iv) scheduled upper or lower respiratory tract surgery, (v) expected difficult airway (e.g., Mallampati 3-4, thyromental distance <6 cm, and short muscular length), (vi) chronic organ failure, and (vii) procedures lasting more than 2 hours, as well as (viii) patients for whom consent could not be obtained.

Anesthetic Protocol

The children were not allowed to consume solid or fluid foods for 6 hours preoperatively. No premedication was administered to the patients before the procedures, and standard American Society of Anesthesiologists Physical Status monitoring (electrocardiogram, non-invasive blood pressure, and pulse oximetry) was performed.

Given the length of surgery and the clinical characteristics of the patients, we decided to use a laryngeal mask (LMA) or perform endotracheal intubation. The LMA was placed during anesthesia induction by administering 4 mg/kg intravenous (IV) propofol; 0.6 mg/kg IV rocuronium was also administered to those who underwent tracheal intubation, with endotracheal intubation performed after adequate muscle relaxation. O_2/air (FiO_2 40%), 1 MAC (age-adjusted) sevoflurane, and remifentanil IV infusion (0.2-0.5 mcg/kg/min) were used for maintenance of anesthesia. The remifentanil infusion rate was determined by considering hemodynamic parameters. In patients who were intubated with muscle relaxants, 0.05 mg/kg neostigmine and 0.02

mg/kg atropine sulfate reversed neuromuscular blockade. Tracheal extubation was performed after the return of satisfactory spontaneous breathing and protective reflexes. All patients were administered 15 mg/kg IV paracetamol at the end of the operation. Patients <8 years old were administered 0.5 mcg/kg fentanyl, while patients ≥8 years old were administered 1 mg/kg tramadol as a rescue analgesic.

Outcomes

Parents were asked to provide basic demographic information about their children, such as age, sex, and medical conditions (presence of an allergy, history of surgery, and diagnosed diseases) as well as their household tobacco consumption. Respiratory complications (desaturation SpO_2 <92%, bronchospasm, laryngospasm, increased airway secretion, cough, breath-holding spells lasting longer than 15 seconds, wheezing, and croup) were recorded before induction, during the intraoperative period, after extubation, and in the post-anesthesia care unit (PACU).

The children were divided into two groups: parental smoking (PS) and non-PS groups. At least a parent/caregivers in the PS group smoked cigarettes at home. In the non-PS group, none of the parents smoked cigarettes at home. Close exposure was defined as either parent/caregiver smoking inside a room/car with the child present. It was considered distant exposure if they smoked on the balcony, in another room, or when the child was absent.

The sample size was calculated using Minitab 16 (2013 Minitab Inc.) program. To determine the exposure status of children, the consumption number of the parents was considered. In the pilot study, including the parents of 10 patients, the average cigarette consumption was 15.2±2.18 packs/year. The sample size calculation revealed that at least 88 patients were needed to reach a significant level of 0.05 and 90% power. Taking into account-possible data losses, with an increase of 10%, we decided to include 98 patients in the study.

Statistical Analysis

The Statistical Package for the Social Sciences application (version 26) was used for statistical analysis (IBM Corp. Armonk, NY, USA). The Kolmogorov-Smirnov test was used to analyze the normal distribution of the groups. Based on the normality test results, data are presented as mean ± standard deviation or median for quantitative data and frequency (percentage) for categorical data. The Mann-Whitney U test or Student's t-test was used to compare quantitative variables, whereas the chi-square test was used to compare categorical variables. A p-value of <0.05 was considered statistically significant for all tests.

RESULTS

In total 125 patients were assessed for eligibility, and finally 98 of them were analyzed. Excluded patients are indicated in the flow diagram (Figure 1). The mean age of the 98 pediatric patients in this study was 63.07±48.7 (range: 1-225)

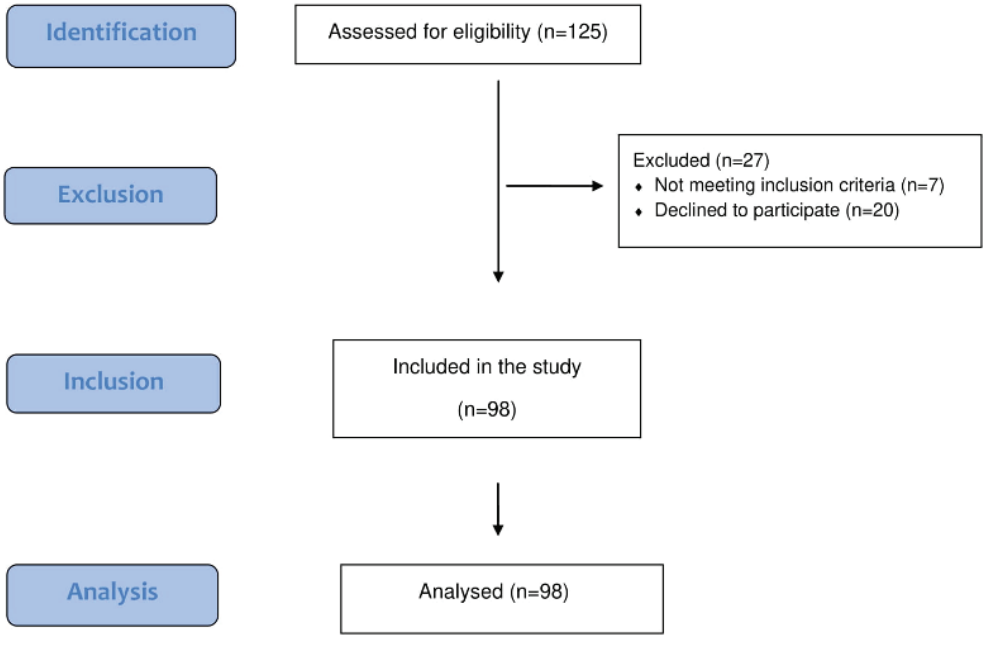

Figure 1. Flow diagram of patient data distribution

months, and 64 (65.3%) were males. The demographic data of the patients, a type of surgery, and duration of surgery are shown in Table 1. While only the fathers of 42.9% of the children and the mothers of 2.0% of the children smoked, both parents of 12.2% of the children smoked. While 14 smoking mothers consumed an average of 8.2±5.1 packs per year, 54 smoking fathers consumed an average of 10.5±5.6 packs per year. In terms of the consumption amount, no difference was observed between the mothers and fathers (p=0.13). In terms of cigarette exposure distance, 42.9% of the children had no exposure, 20.4% had close exposure, and 36.7% had distant exposure.

When the incidence of additional respiratory complications was examined based on the evaluation times, most complications were observed following extubation. The most common complications were laryngospasm, increased airway secretion, and breath-holding spells.

During the evaluation period, 27 (27.6%) children developed at least one respiratory complication. No statistically significant difference was observed in the development of complications based on the sex of the child, exposure time, duration and type of surgery, airway management, and number of cigarettes consumed by the parents (p>0.05). However, the incidence of complications was significantly higher in those exposed to cigarette smoke than in those who did not (35.7% and 16.7%, respectively; p=0.03). While there was no statistically significant difference in complications based on which parent smoked (p=0.14), the incidence was lowest in those who had never been exposed to cigarettes (16.7%) and highest in those who had close exposure (40.0%). However, no statistically significant difference was observed between them (p=0.09). According to the linear-by-linear chi-square results, the incidence of complications increased as the distance of cigarette exposure decreased (p=0.03) (Table 2).

When each type of complication that occurred during extubation was individually compared with the child's

Table 1. Demographics: Anesthetic and surgical characteristics of the patients

Variables	
Gender	Male 64 (65.3)
	Female 34 (34.7)
Age (months)	63.07±48.7 (1-225)
Airway management	Endotracheal tube 59.2
	LMA 40.8
Surgery type	Urogenital (39.8)
	Abdomen (26.4)
	Ophthalmic (20.4)
	Limb (13.3)
ASA physical status	ASA-1 68 (69.4)
	ASA-2 29 (29.6)
	ASA-3 1 (1.0)
Surgery time (min)	69.5±27.9 (20-120)

Data are expressed as mean ± standard deviation, (minimum-maximum) or number (%).
ASA: American Society of Anesthesiologists, LMA: Laryngeal mask

Table 3. Respiratory complications observed during extubation in the awakening process in children exposed to smoking

Variables	Smoking exposure yes (n=56)	Smoking exposure no (n=42)	p-value
Desaturation	6 (10.7)	2 (4.8)	0.46
Laryngospasm	13 (23.2)	4 (9.5)	0.07
Increased airway secretion	9 (16.1)	3 (7.1)	0.22
Coughing	4 (7.1)	0 (0.0)	0.13
Breath holding	8 (14.3)	3 (7.1)	0.34
Wheezing	5 (8.9)	1 (2.4)	0.23

Data are expressed as number (%).

Table 2. Comparison of complications according to smoking exposure among the patients

Variables		Complication not observed (n=71)	Complication observed (n=27)	p-value
Smoking exposure	No	35 (83.3)	7 (16.7)	0.03
	Yes	36 (64.3)	20 (35.7)	
Exposure distance	Not exposed	35 (83.3)	7 (16.7)	0.09
	Distant	24 (66.7)	12 (33.3)	0.03*
	Near	12 (60.0)	8 (40.0)	

Data are expressed as number (%). *Linear-by-linear chi-square

exposure to smoking (Table 3) and the parent that smoked (Table 4) ($p>0.05$), no statistically significant difference was observed.

DISCUSSION

More than 50% of the patients in our study were exposed to cigarette smoke, which increased the incidence of respiratory complications during extubation, particularly during the awakening process. Laryngospasm increased airway secretion, and breath-holding spells were the most common complications. Although the airway management technique (endotracheal intubation vs. LMA) had no effect on the frequency of complications, it increased as the distance of exposure decreased.

According to our findings, 57.1% of the children included in this study were exposed to cigarette smoke. While similar ratios were revealed in cigarette smoke exposure studies conducted in Türkiye in different years (8-10), these ratios were lower in studies conducted in the United States (11-13). Türkiye is a country with high rates of cigarette consumption (14). However, for many years, the world and Türkiye have been engaged in a comprehensive struggle against smoking addiction. Türkiye was one of the two countries that most successfully implemented measures in accordance with the World Health Organization Framework Convention on Tobacco Control (15). With the policies in place, tobacco use is expected to fall to 20.4% globally and 29.9% in Türkiye by 2025 (16). However, the exposure rates revealed in our study and previous studies highlight the importance of combating smoking addiction and continuing these measures.

In our study, we observed that smoking increased the likelihood of respiratory complications by approximately three-fold, which is consistent with the findings of Chiswell et al. (7) (~2.5 times) systematic review. Jones et al. (12) discovered that the risk of intraoperative laryngospasm and airway obstruction in children exposed to passive smoking was 4.9 and 2.8 times higher, respectively, than in those who did not. According to Lakshmipathy et al. (17), the risk of laryngospasm during anesthesia awakening can increase by up to 10-fold in the presence of cigarette smoke exposure. However, some studies have shown that cigarette smoke exposure has little effect on airway complications (13,18,19). For instance, Thikkurissy et al. (13) found that cigarette smoking had no effect on respiratory events in patients undergoing dental treatment under general anesthesia. They hypothesized that this was because the study included relatively healthy children and excluded patients whose smoking exposure caused a more serious morbidity during the preoperative evaluation. In another study, no relationship was observed between cigarette exposure and respiratory complications (19). Nonetheless, the vast majority of research suggests that cigarette smoke exposure harms children's health and increases perioperative respiratory complications.

Exposure to cigarette smoke is a known preoperative risk factor for respiratory complications among pediatric patients in PACU (20). According to Seyidov et al. (9), complications occurred in 12 of 234 patients who had a history of exposure during surgery and 38 patients in the PACU. In contrast, Drongowski et al. (11) indicated that the frequency of respiratory events occurring during emergence from anesthesia and the time spent in the recovery room were comparable. Unlike others, complications were most frequently observed during extubation during the awakening process in our study. In the PACU, respiratory complications developed in three patients. This may be attributed to the early detection of complications during the extubation period and the transfer of patients to the PACU after the required interventions were performed.

Our study, which demonstrated that the most common respiratory complications were laryngospasm, increased

Table 4. Distribution of symptoms observed in children according to their parents' smoking status during extubation in the awakening process

Variables	Mother only (n=2)	Father only (n=42)	Both (n=12)	None (n=42)	p-value
Desaturation	0 (0.0)	6 (14.3)	0 (0.0)	2 (4.8)	0.26
Laryngospasm	0 (0.0)	11 (26.2)	2 (16.7)	4 (9.5)	0.21
Increased airway secretion	0 (0.0)	8 (19.0)	1 (8.3)	3 (7.1)	0.35
Choughing	0 (0.0)	4 (9.5)	0 (0.0)	0 (0.0)	0.13
Breath holding spells	1 (50.0)	7 (16.7)	0 (0.0)	3 (7.1)	0.09
Wheezing	0	4 (9.5)	1 (8.3)	1 (2.4)	0.55

Data are expressed as number (%)

airway secretion, and breath-holding spells, showed both differences and similarities with the literature. In the literature, laryngospasm, bronchospasm, and cough have been reported most frequently in children exposed to cigarette smoke (7). Drongowski et al. (11) reported cough and shortness of breath as the most common complications, whereas Lyons et al. (18) reported desaturation in the PACU as the most common complication. According to a previous report, being exposed to cigarette smoke and having a reactive airway can increase a child's risk of laryngospasm by up to 10-fold (17). Laryngospasm was the most frequent complication observed in our study. Other factors that increase the risk of laryngospasm besides cigarette smoking could be related to the patient, anesthesia, or surgical procedure. The risk factors include young age, superficial anesthesia, blood, secretions, inexperienced anesthesiologist, ear, nose, and throat surgery, and urological procedures (21,22). In our study, anesthesia was administered to all patients by the same team, and the frequency of complications did not vary based on the type of surgery.

Various outcomes have been reported in studies examining the effects of LMA or endotracheal intubation on anesthesia-related airway complications. In their meta-analysis, Li et al. (23) revealed that LMA reduced perioperative respiratory episodes, particularly in pediatric patients. However, cigarette exposure was not considered in this study. When patients with complications were compared based on airway treatment, no significant differences were detected in our study. Similar studies in the literature suggest that supraglottic airway and endotracheal intubation in airway management have no effect on the occurrence of complications in children exposed to cigarette smoke. In a study conducted among children undergoing general anesthesia in day surgery, no difference in complication development was reported between children who underwent airway management with a face mask, LMA, or endotracheal tube (18). Another study reported that the frequency of complications in children with or without cigarette smoke exposure did not differ significantly when LMA ProSeal or intubation was used (9). Although it is difficult to draw conclusions from the available data, we observed that the use of LMA in children exposed to cigarette smoke did not reduce the development of respiratory complications in our study.

Our study revealed that as the distance of cigarette exposure decreased, the frequency of complications increased. The amount of smoke that reaches a person exposed to cigarette smoke is affected by the size of the area, the amount of air change in the environment, and the distance from the source of the smoke (24). In an experimental study, Licht et al. (25) reported that the amount of respirable suspended particles increased as the distance between the smoking location and the monitor used for measurement decreased. Hence, it is not surprising that the associated side effects worsen as exposure increases. The benefits of 'smoke-free airspace' rules in public places to protect public health have been demonstrated recently. However, a consequence of this could be increased household smoking. Legal restrictions on cigarette consumption on private property seem impossible. Therefore, raising awareness and encouraging parents to create smoke-free houses may be beneficial in protecting their children's health.

This study has some limitations. With a larger sample size, we could have developed a correlational study design to investigate the relationship between cigarette smoke exposure and respiratory complications. Furthermore, we determined the amount and distance of exposure of the children based on parental statements.

CONCLUSION

In our study, we found that a history of PS exposure increased the likelihood of respiratory complications in children undergoing general anesthesia, and the frequency of complications increased as the distance of exposure decreased.

ETHICS

Ethics Committee Approval: This was a single-center prospective cross-sectional study and was approved by the Ondokuz Mayıs University Clinical Researches Ethics Committee (decision no: OMÜ KAEK 2022/103, date: 15.03.2022).

Informed Consent: Written informed consent was obtained from all parents before their children enrollment in the study.

Authorship Contributions

Surgical and Medical Practices: S.B., B.D., E.T., Ö.T., Concept: S.B., C.K., B.D., E.T., G.E., S.B., Design: S.B., C.K., B.D., G.E., Ö.T., Data Collection or Processing: C.K., E.T., G.E., S.B., Analysis or Interpretation: C.K., B.D., E.T., S.B., Literature Search: S.B., E.T., G.E., Ö.T., S.B., Writing: S.B., C.K., B.D., E.T., G.E., Ö.T., S.B.

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