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The safety of paediatric dentistry procedures under general anaesthesia. A five-year experience of a tertiary care center

ABSTRACT

Aim *Frequently general anaesthesia (GA) is used to treat noncompliant children. Especially in children with morbid diseases general anaesthesia can be a challenging procedure for anaesthetists. The aim of this paper was to evaluate the risks and adverse reactions with a special focus on the impact of existing medication conditions and syndromes.*

Materials and methods *Records of children up to 10 years of age, who were admitted for paediatric dentistry procedures under GA from January 2011 to December 2016 at the University Hospital of the University of Aachen (Germany), were reviewed. A special attention was paid to the intra- and perioperative critical adverse reactions and concomitant systemic conditions and their impact on treatment outcome.*

Results *Two hundred and twenty patients were admitted for dental restorations. Critical adverse reactions occurred in 4% of the treated patients and they were statistically significantly (p=0.004) related to the ASA classification above II. The use of a laryngeal mask airway was significantly associated (p<0.001) with a shorter duration of surgery. Most common concomitant medical conditions were congenital heart disease, mental retardation and inherited syndromes.*

Conclusion *Although the administration of general anaesthesia in infants and children can be regarded as a safe procedure, clinically significant adverse reactions can occur, especially in patients with an existing medical condition.*

Keywords *Adverse reactions; General anaesthesia; Medical conditions.*

Introduction

Although the incidence of tooth decay and periodontal disease in children is decreasing in Western societies during the last decades, they remain the most frequent indication for conducting treatment under general anaesthesia due to the low compliance of young patients or in patients with underlying medical conditions [Jordan et al., 2014; Konig et al., 2009].

Since the implementation of specialised paediatric dental visits to schools and kindergartens, and the fluoridation of salt and tooth paste, along with the increased awareness of the general population towards oral health, the incidence of tooth decay in children up to the age of 12 has dropped in (Western) Germany by 90% in the last 30 years [Jordan et al., 2014]. However, routine operative dental treatments continue to be perceived as invasive treatments by children, resulting in fear. This increased level of stress and fear of dental procedures can be attributed to the exposure to the environment of the dental operatory unit, the noises made by mechanical dental instruments, the exposure to dental injections and the perception of pain, and also by the visible stress which may be apparent on their parents [Feigal, 2001; Paglia, 2016]. The combination of those factors frequently leads to noncompliance of children and loss of cooperative behaviour, stressed parents and dentists. This particular issue becomes more evident in children with medical conditions or congenital syndromes. In fact, these medically compromised patients are more likely to be treated under general anaesthesia due to decreased compliance. However, they are also more likely to have congenital anatomical anomalies and altered physiological structures, and thus higher risk of intra- and perioperative cardiac and pulmonary complications [Mafrica and Fodale, 2006; Nargozian, 2004]. Nevertheless, general anaesthesia is considered as a safe routine procedure in healthy children and the literature reports mostly mild complications, such as postoperative pain, nausea, and vomiting [Loyola-Rodriguez et al., 2004; Escanilla-Casal et al., 2016].

This study aims at investigating the perioperative complications of general anaesthesia performed because of dental indications in the paediatric population. We reviewed patients up to 10 years of age for general characteristics, course of anaesthesia, and the presence of critical events. A focus was set on patients with medical diseases or congenital syndromes to investigate if they present with higher incidences of severe complications.

Since the potential harm from general anaesthesia in children arises not only from immediate perioperative complications, but also from long-term side effects and metabolic changes, we have also performed a literature review for the discussion of long-term effects of general anaesthesia in childhood.

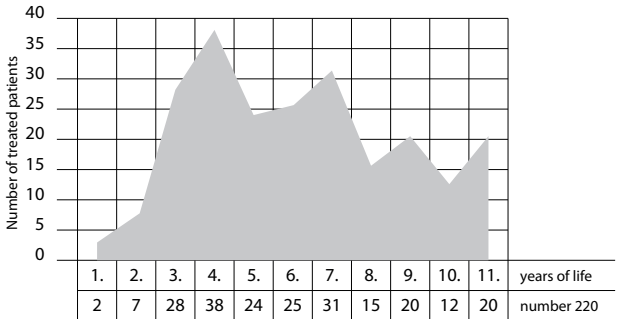

FIG. 1 Age distribution: Evaluating the distribution of treated patients in dependence to age, there is a peak incidence by the age of 4 and 7 years.

Materials and methods

In this retrospective study we reviewed the clinical data of paediatric patients who had been admitted to university hospital of Aachen (Germany) from January 2011 through December 2016 for dental treatments under GA. Dental conditions included carious teeth resulting in a filling or a dental extraction, as well as odontogenic abscesses which had to be incised and drained under general anaesthesia. Children treated under general anaesthesia for other reasons, such as trauma or cleft lip and palate and concomitant dental treatment, were excluded from the study due to confounding factor of the underlying medical condition, and subsequently higher risk for perioperative complications. Collected data included age, gender, general diseases, weight and body mass index of the children, as well as anaesthesia-related parameters such as ASA-classification, method of ventilation, perioperative anaesthesia, and surgical complications. Critical events were distinguished between life-threatening (severe) and non-life-threatening (mild) events. Underlying medical conditions and congenital syndromes were represented by congenital heart diseases, congenital syndromes, pulmonary diseases, mental retardation, and haematological disorders.

Statistical analysis was performed with SPSS software version 23.0. The p-values were assessed with t-tests for continuous variables, and with chi-square-tests for nominal or ordinal values. Values were considered to be significant with a $p < 0.05$.

Results

The number of children up to 10 years of age treated under general anaesthesia was 485. Of them, 220 had a diagnosis of dental aetiology with male-female ratio of 1.4–1. The average age of patients was 5.9 years. Children receiving oral intubation (mean age 5.9 years) were significantly younger (p=0.01) than patients with nasal intubation (mean age 7.3 years), and significantly

	Oral tube (n=164).	Nasal tube (n=28)	p*	Laryngeal mask (n=28)	p*
Age (years)	5.9	7.3	0.01	4.5	0.01
Weight (kg)	20.7	25.9	0.02	18.7	0.28
Size (meter)	1.16	1.20	0.91	1.41	0.55
BMI	15.4	16.8	0.08	16.1	0.24
Duration of narcosis (hours)	1:13	1:25	0.12	0:26	<0.001
Hospitalisation (days)	1.38	1.22	0.65	1.44	0.87

TAB. 1 General characteristics of patients. Patients with endotracheal nasal intubation and laryngeal mask airway ventilation were compared to patients with oral intubation.

(p=0.01) older than patients with laryngeal mask (Table 1). There was a peak incidence in the number of patients treated under general anaesthesia at the age of four years, likewise at the age of seven years (Fig. 1). The duration of general anaesthesia was on average 1h 12m (range: 0:11–3:25 h). The duration of laryngeal mask anaesthesia (0:26 h) was significantly (p<0.001) shorter than oral intubation (1:13 h) (Table 1). Conservative dental treatment, defined as dental fillings and restoration of teeth without extraction, was performed in 11% (n=24) of patients. In 49% (n=108) of the patients, only surgical treatment–including teeth extraction and abscess incision–was performed, and in 40% (n=88) of the children, a combination of both treatments was performed. In 11% (n=24) of the subjects, abscess incision and drainage was performed intraoperatively, suggesting that these cases were emergency interventions.

Overall, 72% (n=159) of the patients were classified as ASA I, 17% (n=38) as ASA II, 10% (n=21) as ASA III, and 1% (n=2) as ASA IV, respectively. Intra- and perioperative complications were statistically significantly (p=0.004) related to ASA classification III and IV (Table 3). The most common underlying medical conditions were congenital heart diseases (n=24; 11%) and mental retardation (n=22;

	All patients	Congenital heart disease	Syndromal diseases	Pulmonary diseases	Mental retardation	Haematological disorders
Number (%)	220 (100)	24 (11)	14 (6.4)	10 (4.5)	22 (10)	5 (2.3)
Age (years)	5.71	5.64	7.4	5.66	7.0	4.72
p		0.88	0.01	0.89	0.01	0.14
Weight (kg)	20.9	16.9	21.6	18.5	24.3	19.7
p		0.02	0.74	0.38	0.08	0.76
Size (meter)	1.21	1.18	1.15	1.09	1.22	1.12
p		0.2	0.18	0.68	0.94	0.83
BMI	15.6	14.2	15	14.7	16.4	14.8
p		0.01	0.93	0.32	0.13	0.53
Duration of narcosis	1:18 h	1:19 h	2:20 h	1:19 h	1:32 h	1:21 h
p		0.94	<0.001	0.95	0.35	0.93
Hospitalisation (d)	1.38	2	1.21	1.21	1.05	1.34
p		0.08	0.74	0.63	0.38	0.98
Complications (%)	7 (3)	1 (5)	0 (0)	0 (0)	2 (10)	1 (16)
p		0.15			0.09	0.1

TAB. 1 Characteristics of patients with congenital diseases. Overview of general characteristics and complications.

10%). Age of patients with syndromes (7.4 years) and mental retardation (7.0 years) was significantly (p=0.01) higher than in healthy patients (5.71 years). Weight of patients with congenital heart disease (16.9kg vs. 20.9kg; p=0.02) as well as body mass index (14.2 vs. 15.6; p=0.01) were significantly lower than the average for subjects in the study. Average duration of anaesthesia was 1:18 h and appeared to be significantly (p<0.001) longer in patients with syndromes (2:20 h). Duration of hospitalisation and number of complications were not significantly associated with any concomitant medical condition or syndrome. All results are listed in Table 2. Critical events occurred in 7 patients (4%). In 4 cases (2%), the tube had to be changed after intubation had already been performed due either a leakage in the cuff, or non-matching tube size. Two patients (1%) vomited milk during the induction phase or recovery from anaesthesia. This occurred in both cases despite fasting from oral intake for at least six hours prior to surgery. In one case (0.5%), a severe ventilation-related event resulting in decreased oxygen saturation to 67% occurred although the tube was properly placed, and symptoms resolved after endoscopical removal of mucus from the trachea (Table 3).

Average duration of hospitalisation was 1.38 days; 43% (n=95) of the patients were treated in outpatient setting. Furthermore, 23% (n=51) and 17% (n=37) of patients were discharged on the first and second postoperative day respectively, whereas 9% (n=20) were hospitalised for more than 5 days (Fig. 2). Prolonged hospital stay was caused by protracted clinical course of odontogenic infections and episodes of postoperative bleeding.

	No complications (%)	Complication (%)
ASA*		
1	156 (99)	3 (1)
2	37 (97)	1 (3)
3	18 (87)	3 (12.5)
4	2 (100)	0 (0)
Anesthesia		
Oral intubation	155 (96)	7 (4)
Nasal intubation	27 (100)	0 (0)
Laryngeal mask	27 (0)	0 (0)
Type of complication		
Change of tube (due to not matching size or leakage)		
Vomiting during introduction/ intraoperative/ recovery from anaesthesia		
Ventilatory problems during surgery with endoscopical pulmonary suction		
Number of complications is significantly associated with ASA >2 (p=0.004)		

TAB. 3 Complications in dependence on ASA classification and means of narcosis.

Discussion

Our data suggest that there is a low incidence of perioperative critical events in children undergoing general anaesthesia for dental procedures. In fact, only 0.5% of all cases were associated with severe complications, however there was no mortality (Table 2). Our findings are comparable to those of other studies, which report the incidence of anaesthesia-related critical events between 0% and 20% in children undergoing general anaesthesia for restorative dental reasons [Kim et al., 2015; Chan et al., 2015]. Farsi et al. [2009] describe pain, inability to eat, and nausea as the most frequent complaints of children after surgery, which decrease significantly on the third postoperative day.

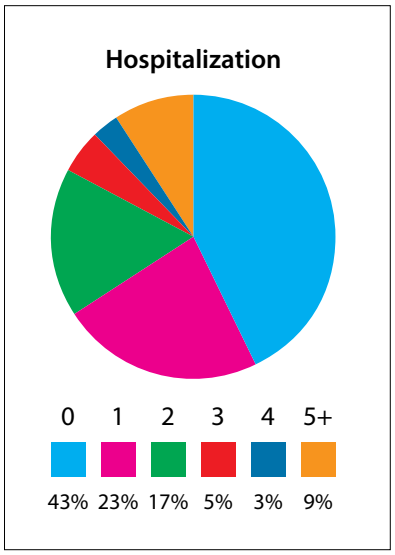

FIG. 2 Duration of hospitalization. In most cases, procedures were performed in an ambulatory setting. In 9% a hospitalisation of more than five days was necessary. Persisting odontogenic infections and episodes of bleeding were the leading reasons for the prolonged stay.

The incidence of complications was significantly (p=0.004) associated with ASA III and IV. In 13% of patients classified as ASA >II, critical events occurred. This was reflected on the duration of anaesthesia, which was significantly (p<0.001) longer in patients with preexisting conditions. Challenges for anaesthesiologists are not only related to anatomical aberrations, which lead to a more protracted induction time, but also to variation in drug metabolism and pharmacokinetics, along with alterations in the cardiopulmonary functional capacity [Nargozian, 2004; Mafrica and Fodale, 2006]. There were no additional significant differences in duration of hospitalisation, which may indicate a good postoperative management. The most common medical conditions recorded were congenital heart disease, mental retardation or developmental delay, and congenital syndromes. Surprisingly, patients undergoing dental treatments with syndromes and mental retardation were both significantly older (p=0.01) than the average patient. This indicate a good oral hygiene measures guided by the parents and improved care facilities, since compliance to oral hygiene instructions and utilisation of dental cleaning devices is less likely in children with mental retardation without support [Guare Rde and Ciampioni, 2004].

Whether to use a laryngeal mask airway or an endotracheal intubation tube for ventilation is widely discussed in literature. In a systematic review Klucka et al. [2015] reported the increased incidence of mucosal oedema of the trachea, as well as a higher incidence of laryngospasms in patients receiving endotracheal intubation. Other reported advantages of the laryngeal mask airway are less risk of postoperative coughing, as well as shorter duration of clinical surveillance. On the other hand, the main advantage of the endotracheal intubation is prevention of aspiration of saliva, mucus, or gastric contents and lower risk of dislodgement [Klucka et al., 2015]. Several authors investigated the safety of laryngeal airway mask and they reported no increased risk of dislocation or dislodgement of the mask during surgery in the oral cavity when compared to endotracheal intubation tubes [Kim et al., 2015; Klucka et al., 2015; Sierpina et al., 2012]. In our study, the data suggest that laryngeal mask airway is safe. Out of 28 subjects, none presented with intraoperative or postoperative complications, and the duration of surgery was significantly reduced (p<0.001). Nevertheless, it remains uncertain whether the duration of surgery was reduced as a result of using the laryngeal mask airway, or the laryngeal mask was only used in selected procedures that tend to be shorter in nature, which could have resulted in a selected bias. Moreover, endotracheal intubation was also a safe procedure associated with low incidence of critical events. We did not record any occurrence of laryngospasm in children undergoing endotracheal intubation.

In our patients, two out of the seven intraoperative critical events were reported as regurgitation or vomiting of gastric content, even though parents and caring staff reported abstinence from oral food intake for at least six hours prior to surgery. In these cases, a blocked cuff was used during endotracheal intubation and probably prevented more severe damage to the lower airways as a result of the aspiration of the acidic gastric fluid. We can conclude that both ventilation methods are effective in children and each carries its own advantages and disadvantages, which has to be weighted out for each patient individually.

There are several studies and case reports in the literature reporting a significant increase in stress levels in young patients as well as their parents during routine dental treatment sessions, particularly when the procedures are not performed by specialised paediatric dentists [ten Berg, 2008; Porritt et al., 2012; Aoyagi-Naka et al., 2013; Cuadros Fernandez et al., 2014]. Conducting such routine and emergent dental procedures under general anaesthesia has the potential to decrease the stress level of the patient. The working environmental for the medical and dental staff is more relaxed in general anaesthesia, because the dentist can concentrate on the treatment without having to deal with the impatient, anxious, or incompliant behaviour of the children.

The above-mentioned findings suggest that general anaesthesia is a practical and safe approach for dental treatments during childhood, since all involved parties from the family and medical side seem to benefit from a safe and reliable environment. Our finding of a low perioperative risk of the general anaesthesia care in children is consistent with similar findings described in the literature, when performed by experienced anesthesiologists and dentists. Nonetheless, the lack of data on the long-term effects of general anaesthesia may have resulted in the introduction of bias in our study.

In contrast to acceptable commonly reported perioperative side effects and complications, several studies describe the occurrence of significant negative

long-term impact on children's behaviour. Xin Wang et al. [2014] conducted a meta-analysis including 44,143 children younger than 4 years, of whom 5,546 underwent general anaesthesia in childhood, and reported a possible correlation between neurodevelopmental impairment and general anaesthesia. Furthermore, the author suggests a correlation between the number of general anaesthesia exposures in childhood and the degree of neural system development. The more exposure to general anaesthesia during childhood, the more likely that language acquisition, learning ability, cognition, behavioural development, as well as the academic performance were impaired. This appears to be a crucial information affecting the decision making process for paediatric dentistry procedures, and this finding is clinically relevant, especially since our data show that 22% of all general anaesthesia in childhood was performed in children up to the age of four years. In fact, we noticed a peak incidence at the age of four, which represented 15% of all cases in our study.

Several animal model studies suggest a dose-dependent neurotoxicity of standard drugs used in anaesthesia [Wang et al., 2014], which can potentially lead to lifelong behavioural changes [Olney et al., 2002; Mellon et al., 2007]. Mellon et al. [2007] described a higher toxicity levels associated with the anaesthetic drugs when they are combined with other drugs. These reported findings may suggest preferring local anaesthesia to general anesthesia measures, due to the possible negative long-term effects on the developement of the central nervous system.

Another method for handling incompliant patients during dental treatments is by the introduction of sedation. In a study evaluating 60 paediatric patients undergoing dental treatments, Canpolat et al. [2016] described good results with ketamine, propofol, or a combination of both drugs in terms of sedation and side effects. However, the study reported the occurrence of respiratory depression in three patients receiving only propofol [Canpolat et al., 2016]. It is important to emphasise that sedation should be used only by healthcare providers adequately trained in sedation and anaesthetic care. Lee et al. [2013] reported that most deaths during paediatric dentistry sedation occurred in patients between 2–5 years old, in a private office setting, and in the absence of a trained anaesthesiologist on site [Lee et al., 2013].

Conclusion

General anaesthesia for paediatric dentistry procedures is a safe and routine procedure in terms of perioperative management and complications rate. In patients with medical conditions or congenital syndromes, experienced anaesthesiologists are crucial because of the higher risk for complications.

We recommend further investigation of the long-term side effects in general anaesthesia for dental restoration in paediatric patients.

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