

Magnitude and Associated Risk Factors of Perioperative Pediatrics Laryngospasm under General Anesthesia

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Abstract

Background: Several investigators have studied and made recommendations on literatures to reduce the incidence of laryngospasm during anesthesia. Contrastingly it is more frequently happening incident in pediatrics patient and brings a great challenge to anesthesia providers.

Objective: The aim of this study was to identify the magnitude and risk factors associated with perioperative pediatrics laryngospasm and intervention strategies undertaken.

Methodology: Hospital based cross sectional study was conducted on elective pediatrics patients (n=187) operated in Jimma University Teaching Hospital from February 1, 2015 to June 30, 2015.

Result: Of the 53 (28.3%) laryngospasm events identified as cases, 30 (56.6%) occurred during induction, 4 (7.6%) during maintenance and 19 (35.8%) during emergence. 41 (77%) and 12 (23%) events were occurred during perioperative period on the hands of BSC and MSC anesthesia providers respectively. About 62.3% were precipitated by direct airway stimulations. Desaturation occurred in 42 (79.2%) of cases, bradycardia in 37 (69.2%), and cardiac arrest in 3 (5.7%) and there was death in 1.9% of case. There is a strong statistical associations between status of the providers with the incident of laryngospasm (P value is 0.01852356). 35 (66%) of cases were managed by removing the offending stimulus and administration of 100% oxygen with continuous positive pressure and in the absence of response 15 (28.3%) cases were treated with intravenous succinylcholine (0.25 to 1 mg x kg). 3 (5.7%) of children required cardiopulmonary resuscitation. There was no correlation across types of airway management devices utilized with the occurrence of laryngospasm (OR=0.6889, 95% C.I. 0358-1.3257, P=0.263552).

Conclusions: Incidences of laryngospasm and its adverse events at pediatrics age group anaesthetized by junior anesthesia providers were high. Patient with upper respiratory tract infection and operated under general anesthesia with ETT were significant factors for the development of laryngospasm leading to the occurrence of perioperative hemodynamic instability.

Keywords: Airway; Complication; Laryngospasm; Pediatric

Introduction

Laryngospasm is one of the complications seen in the perioperative period especially during induction of anesthesia or during emergence. It consists of prolonged glottis closure reflex mediated by the superior laryngeal nerve [1].

The incidence is higher in children especially in infants 1-3 months of age. The common inciting factors are hyperactive airway like in case of upper respiratory tract infection. Other common triggering factors are painful stimulation and insufficient depth of anesthesia on endotracheal intubation, light anesthesia on tracheal extubation with or without some irritant factors such as blood, mucus, and airway manipulations with laryngoscope blade, suction catheter, surgical debris or other foreign body [1].

Some authors have proposed laryngeal spasm to be a complication of barbiturate induced parasympathetic activity [2]. Among the inhalational agents isoflurane showed greater incidence of laryngospasm than halothane, enflurane and sevoflurane [3].

Laryngospasm is a protective reflex that acts to prevent foreign material entering the tracheobronchial tree. The exaggeration of this reflex may result in partial or complete glottis closure and consequently impeding respiration [4]. If laryngospasm persists, it may cause hypoxia and hypercapnia. Most of the time, the resulting hypoxia abolishes the reflex and the spasm tends to be self-limited [5-7]. However, in rare occasions, serious morbidity and mortality from immediate (hypoxia and hypoxemia) such as cardiac arrest, arrhythmia, delayed ("negative-pressure pulmonary edema") consequences of upper airway or lower airway spasm or aspiration may occur [7-10]. Thus every effort should be made to rapidly relieve the airway obstruction caused by laryngospasm [11].

The Treatment success mainly depends on the experience of the anesthesia provider. The treatment was different for each type [12]. if there is incomplete airway obstruction, remove irritant stimulus, deepen anesthetic plane, apply jaw thrust maneuver, insert guedel airway and provide gentle continues positive airway pressure with 100% oxygen. Pressing firmly at the 'laryngospasm notch' helps to relief the spasm as advocated by Guadagni and Larson [13].

In case of complete airway obstruction suxamethonium is given intravenous. If no intravenous access intramuscular 4 mg/kg is given [14]. On becoming hypoxic and having hemodynamic drain mangle, the child may need to be intubated without muscle relaxation, than to wait for the effects of succinylcholine [15]. The vocal cords can be sprayed with lidocaine, in order to bring relaxation and facilitate intubation [16]. If these methods fail; emergency cricothyrotomy or emergency tracheotomy may be required. However, recent reviews [17,18] derived from endoscopy studies showed that partial laryngospasm does not exist and laryngospasm is complete; thus, treatment should be the same.

Patients with laryngospasm can deteriorate rapidly and help should be sought early; three incidents were reported in which the patient suffered morbidity because of a lack of skilled assistance. It is well recognized from the AIMS database that not only does a lack of skilled anesthetic assistance contribute to adverse events, but that inadequately trained assistants may actually make an adverse event worse [19].

In our setup there is no pediatric anesthesiologist and the number of trained physician anesthesia providers is deficient. Anesthesia for all cases including pediatric patient is often administered by non-physician anesthesia providers. They have no adequate training in pediatrics anesthesia but they are often administering anesthesia for pediatrics patient alone sometimes managed by anesthesiologist with distant supervision. The aim of the study was to identify the magnitude, risk factors associated with perioperative pediatrics laryngeal spasm and anesthetist management strategy made.

Methodology

Study design and setting

Hospital based cross sectional study was conducted on elective pediatrics patients (n=187) operated in Jimma University Teaching Hospital from February 1, 2015 to June 30, 2015.

Ahead of the conduct of the study, Standardized checklist was developed, orientation and discussion was given for the anesthesia providers on how to clinically diagnosis/recognize laryngeal spasm during anesthesia, to minimize or rule out some confounding factors. The diagnosis was made based on the clinical sign symptoms (Inspiratory stridor and decreased or absent air entry with precordial stethoscope, increased inspiratory efforts/tracheal tug, Paradoxical chest/abdominal movements, Desaturation with or without bradycardia, central cyanosis and direct visualization of the vocal cords. Anesthesia providers check their machine and circuit as usual before the start and after the end of each procedure. They were also free to select drugs, equipments, monitoring and types of anesthesia technique they considered appropriate for each patient as usual.

Ethics, study population and eligibility criteria

After approval of hospital ethics committee and informed patient consent data was collected preoperatively by interviewing the parents or guardian and reviewing of their anesthetic records with prepared checklist which include age, sex, ASA physical status, type of surgery planned, type of anesthetic technique and induction agents, status of anesthesia providers and history of co morbidities were addressed. Intraoperative events and postoperative complications, interventions and outcome were recorded for each case. Elective procedures, ASA physical status class I and II were included while age >14 years, emergency cases and regional procedures were excluded

Data analysis

All responses to the questionnaires were coded, entered and analyzed using SPSS Version 16. Findings are summarized using odds ratios (OR) and corresponding 95% confidence intervals. Initial univariate analyses were performed to assess each risk factor individually. Patient demographics, comorbidities and airway device and medications were assessed in an overall analysis that utilized all matched sets of cases and controls. In addition to assessing univariate associations, a series of multivariate analyses were also performed. In all cases two-tailed p-value and 95% confidence interval was used to check statistical significance. Statistical associations were considered significant whenever the p -value is less than 0.05.

Results

The characteristics of respondents

A total of 187 pediatric patients with age range from birth to 14 years (median, 12.0) were included in the study. Among these, 58.3% were females and 41.7% were males. About 64.2% and 35.8% of the cases were ASA physical statuses class I and II respectively (Table 1).

Variables	N (%)
Age (n=53)	
birth - 12 months	11 (20.8)
1 year+ - 5 years	19 (35.8)
5 years+ - 10 years	15 (28.3)
10 years+ - 14 years	8 (15.1)
Sex	
Male	22 (41.5)
Female	31 (58.5)
Status of the Anesthesia providers	
*BSC anaesthetist	41 (77)
*MSC anaesthetist	12 (23)
ASA physical status (n=53)	
Class I	36 (67.9)
Class II	17 (32.1)
Route of Induction and induction agent	

Intravenous (n=36)	
Ketamine	21 (39.6)
Thiopentone	11 (20.8)
Propofol	4 (7.5)
Inhalational (n=17)	
Halothane	14 (26.4)
Isoflurane	3 (5.7)
*BSC: Bachelor of Science *MSC: Masters of Science	

Table 1: The characteristics of respondents.

Magnitude and triggering factors of laryngospasm

Of the 53 laryngospasm events identified as cases, 30 (56.6%) occurred during induction, 4 (7.6%) during maintenance and 19 (35.8%) during emergence. The majority of the incidents occurred in children <10 years of age (35% <5 years of age), 28.3% <10 years of age). There is no correlation between age and the laryngospasm incident (P-value is 0.83764).

In an analysis restricted to case-control sets during induction, maintenance and emergence the risk for laryngospasm was found to be significantly associated with types of induction agents administered (P-value is 0.0439249). The most common types of surgery associated with laryngospasm were ophthalmic and ENT procedures, with 26.4% and 24.6% of incidents respectively (Figure 1).

In cases that involved intubation, laryngospasm tended to occur mainly after extubation during the emergence and recovery stages, while those that involved spontaneous respiration with laryngeal mask occurred mainly during induction or maintenance of anesthesia (Figure 2).

There was no correlation across types of airway management devices utilized with the occurrence of laryngospasm (OR=0.6889, 95% C.I. 0.358-1.3257, P=0.26352) (Table 2) however patient presence of URI, asthmatic history or upper airway anomaly and the use of LMA were significant risk factors for laryngospasm (P value 0.0267).

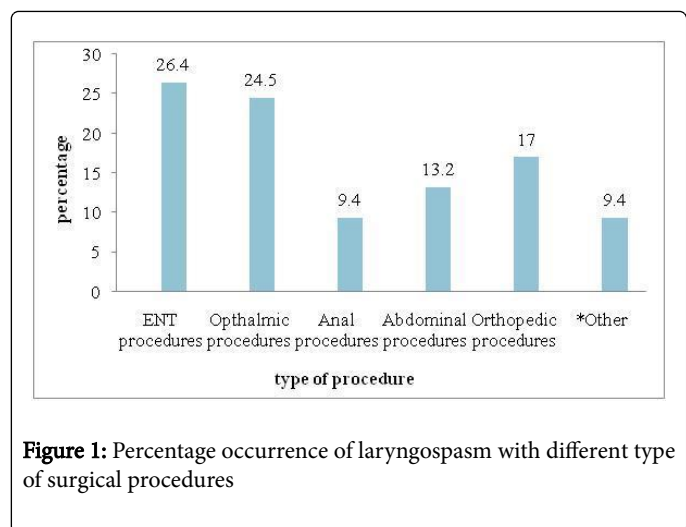


Figure 1: Percentage occurrence of laryngospasm with different type of surgical procedures

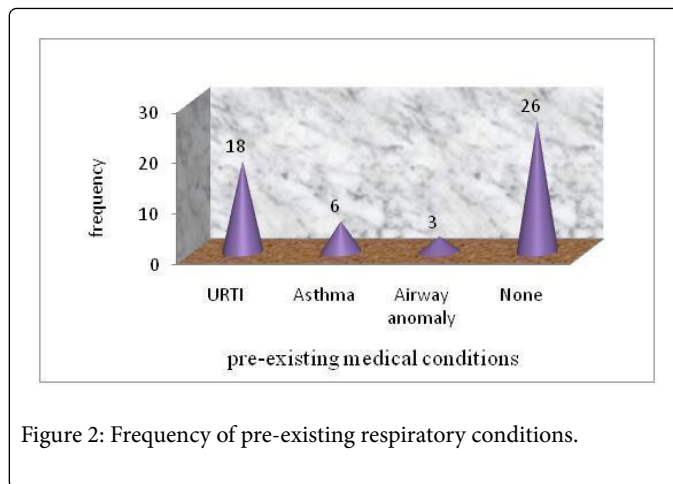


Figure 2: Frequency of pre-existing respiratory conditions.

Airway device	Induction phase (%)	Maintenance phase (%)	Emergency phase (%)	Odd ratio		
				Estimate	95% C.I.	P-value
ETT	19	0	12	1.67	0.358-1.3257	0.26352
aMask	11	4	7	0.57		
Total	56.6	7.6	35.8			

Note: aLMA and Face mask ventilation

Table 2: Type of anesthetic airway device and time of occurrence of laryngospasm.

In this study the main triggering factors were repetitive airway manipulations and light plain of anesthesia accounting about 43.4% and 22.6% respectively. There should be a limitation to the number of attempts as increasing numbers of attempts at tracheal intubation were contributed for the incident associated with increasing severity of morbidity and the associated incident could be correlated with an increased risk of cardiac arrest and death (p=0.0045).

Perioperative complications and intervention strategies undertaken

Overall Perioperative complications identified, the percentage of desaturation, bradycardia, pulmonary aspiration and negative pressure pulmonary edema, cardiac arrest and death were 42 (79.2%), 37 (69.8%), 11 (20.8%), 5 (9.4%), 3 (5.7%) and 1 (1.9%) respectively (Figure 3). Aspiration occurred in 20.8% of cases in 11% of the cases blood or secretions seen in the pharynx mainly with ENT procedures, in 9% of the cases regurgitation or vomiting occurred at emergence period during LMA removal. About 9.8% of cases developed pulmonary edema at early extubation (Figure 4). All cases are managed in similar way by removing the obstruction, supporting with oxygen and reducing the after load. Only one case is re-intubated due to significant hemodynamic instability and rapidly desaturation; the rest of the cases resolved spontaneously without further complications. There was three cardiac arrest during the study period two of them were resuscitated and resolved but one kid underwent abdominal procedure induced with ketamine and intubated with endotracheal tube developed laryngospasm immediately at emergence phase goes to

cardiac arrest despite adequate resuscitation the patient was died (Figure 5).

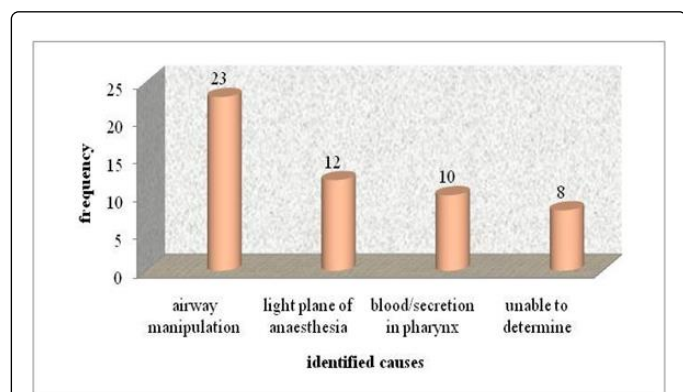


Figure 3: Frequency of the identified causes of perioperative laryngospasm.

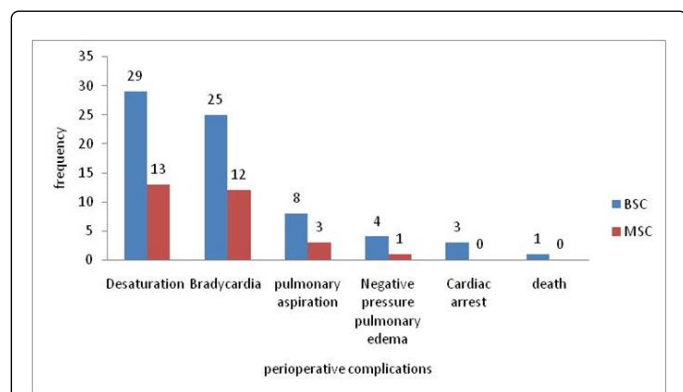


Figure 4: Frequency of Perioperative complications identified following incidents of laryngospasm by providers.

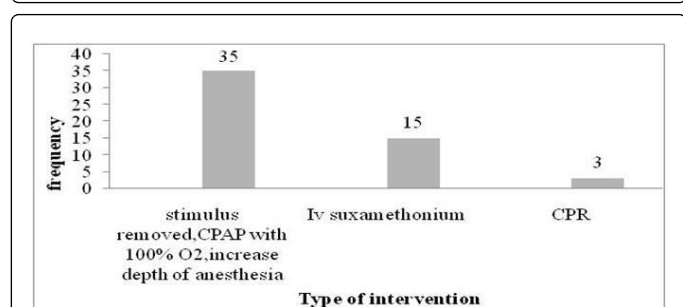


Figure 5: Frequency of management made for the treatment of perioperative laryngeal-spasm by providers.

Discussion

Airways management is fundamental for anesthesiologists, especially during induction of anesthesia and emergence period, when laryngeal spasm is more common. The anesthesiologist should know pharyngeal-laryngeal physiology and the risk factors for airways obstruction, since this is a potentially severe complication with a

multifactorial etiology that can develop during anesthesia and whose consequences can be seriously catastrophic [18].

Olsson et al. [7] found the overall incidence of laryngospasm in the largest 11 year prospective study (of 136929 patients) to be 7.9/1000 anesthetics or 8.7/1000 patients.

The incidence in children 0-9 years of age was higher 17.4/1000 patients and within this age group infant's 1-3 months of age had the greatest incidence (more than three times the rate in any age group).

In the current study the overall incidence of perioperative pediatrics laryngeal spasm was 28.3%, comparatively higher than that of reported previously. The inciting factors associated with an increased incidence of laryngeal spasm were upper respiratory tract infections, awake extubation, type of the induction agents. The result is similar with the report from AIMS extubation (42/1000), NG tube insitu (48.5/1000) and oral endoscopy and esophagoscopy (48.5/1000) and the incidence of laryngo-spasm was highest 95.8/1000 in children with respiratory tract infection.

In this study there was no statistical correlation between types of air way devices used with the occurrence of laryngospasm (OR=0.6889, 95% C.I. 0358-1.3257, P=0.263552). Contrastingly Study [20] reported within the examined patient cohort, the rate of laryngospasm was comparable between different airway devices (1.12% ETT, 1.7% LMA and 1.5% face mask).

In the current study the main triggering factors were repetitive airway manipulations and light plain of anesthesia accounting about 43.4% and 22.6% respectively. Even though ASA guideline for pediatrics anesthesia does not recommend the use of cured blades and cuffed endotracheal tube for less than 10 years old children. From our observation cuffed endotracheal tubes and Macintosh blades were frequently used causing adverse effects, periglottic edema, which makes intubation and ventilation more difficult or impossible. It is necessary to establish back-up plans appropriate to the patient, to be deployed if the primary plan fails. There should be a limitation to the number of attempts as increasing numbers of attempts at tracheal intubation were contributed for the incident associated with increasing severity of morbidity and the associated incident could be correlated with an increased risk of cardiac arrest and death (p=0.0045)

In a survey of United States anesthesiologists deep extubation is performed by 64% of the interviewed practitioners [21] the study of Koga et al. [22] has shown that the rate of airway obstruction in patients' extubated during deep anesthesia (17/20) was not higher than in patients' extubated after regaining consciousness (18/20).

Aspiration occurred in 20.8% of cases in 11% of the cases blood or secretions seen in the pharynx mainly with ENT procedures, in 9% of the cases regurgitation or vomiting occurred at emergence period during LMA removal.

About 9.8% of cases developed pulmonary edema at early extubation. All cases are managed in similar way by removing the obstruction supporting with oxygen and reducing the after load. Only one case is re-intubated due to significant hemodynamic instability and rapidly desaturation; the rest of the cases resolved spontaneously without further complications. There was three cardiac arrest two of them were resuscitated and resolved but one kid underwent abdominal procedure induced with ketamine and intubated with endotracheal tube developed laryngospasm goes to cardiac arrest immediately at emergence phase despite adequate resuscitation the patient was died.

Mamie et al. [23] reported that children not anesthetized by pediatric anesthesiologist have a 1.7 times greater risk of perioperative RAE (these events included laryngospasms). Similarly, children who developed laryngospasm were more likely to have their anesthesia supervised by a less experienced anesthesia supervisor.

The figure from AIMS database report reveals it is not only lacks of skilled anesthetic assistance contribute to adverse events, but that inadequately trained assistants may actually make an adverse event worse [19].

In this study, there is statistical correlation between status of the providers with the incidence of perioperative laryngospasm and perioperative complications at (P value of 0.01715 and 0.00267 respectively), however, we could not confirm that procedures supervised by pediatric anesthesiologist reduce the risk for laryngospasm or not. There are no cases managed by physician anesthesiologists.

Limitation of the Study

It was difficult to determine the exact location of upper airway obstruction under anesthesia based on clinical signs alone. So it is difficult to make firm conclusions.

Conclusions

Incidences of laryngospasm and its adverse events at pediatrics age group anaesthetized by junior anesthesia providers were high. Patient with upper respiratory tract infection and operated under general anesthesia with ETT were significant factors for the development of laryngospasm leading to the occurrence of perioperative hemodynamic instability.

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Disclosure

The authors report no conflicts of interest in this work.

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