

ORIGINAL RESEARCH

Medicine Science 2018;7(4):769-72

Airway management of difficult intubation in the pediatric population: A single center experience

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Received 07 April 2018; Accepted 18 April 2018

Available online 24.07.2018 with doi: 10.5455/medscience.2018.07.8853

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Abstract

Awareness and the management of the difficult airway in children are crucial. Although the incidence of difficult intubation in children is believed to be lower than in adults, there is insufficient data regarding it. The aim of this study was to determine what airway management techniques are being applied in the difficult airway situation, by a group of experienced Consultant Anesthetists, in a large pediatric center. The study conducted over a 2-year period, in a large pediatric hospital. For a 2-year period beginning from September 2014, consultant anesthetists completed pro-forma following all pediatric anesthesia procedures in which tracheal intubation was difficult. The collected information included: patient demographics; airway assessment; anesthetic technique and airway management strategies employed; and reasons of failure in intubation attempts. There were 50 cases which were assessed as difficult intubation, and 80% of the cases had an anticipated difficult intubation report with 40% having a history of previous difficult intubation. Fiberoptic Bronchoscope (FOB) was the first-choice rescue technique in 84% of the patients; 92% of oral FOB and 71% of nasal FOB were successful. Six cases required surgical airway as surgical tracheostomy. This study created a screenshot of the various methods used when we were faced with a difficult airway management in pediatric population. Fiberoptic intubation remains overall the best method whereas no method was 100% successful. The majority of the patients had anticipated difficult airway, which opportunely allows planning for surgical airway with other teams such as Ear-Nose Throat and pediatric surgery.

Keywords: Difficult airway, pediatric, fiberoptic bronchoscope, tracheostomy, video laryngoscope**Introduction**

Awareness and the management of the difficult airway in children is crucial. Even the normal anatomy of younger children can be difficult to manage for anesthesiologists with limited pediatric experience. Restricted head extension, small mandibular space, increased size of the tongue, craniofacial dysmorphism and distinct distances from the lower lip to the chin and the ear tragus to the mouth are associated with difficult intubation conditions [1]. Similarly, in preschool and older children, adenotonsillar hypertrophy is common and the narrowest portion of airway may be at the tonsillar level. Furthermore, high metabolic demands and low oxygen reserves shorten the time to significant hypoxemia during apnea associated with tracheal intubation [2].

Although the incidence of difficult intubation in children is believed to be lower than in adults [3], there is insufficient data regarding it [4].

Fiberoptic intubation has been described as a useful technique in pediatric anesthesia [1] and probably remains (to be) the most

common approach in the difficult airway. Newer devices, such as the video laryngoscope, have also been used with success in the pediatric difficult airway [5,6].

The aim of this study was to determine what airway management techniques are being applied

in the difficult airway situation, by a group of experienced Consultant Anesthetists, in a large pediatric center.

Materials and Methods

After obtaining approval from Institutional Review Board, the study was conducted over a 2-year period, in a large pediatric hospital performing 4000-6000 pediatric surgical procedures per year; analysis of the database suggests approximately 60-70% will be intubated. For a 2-year period beginning (from) September 2014, Consultant Anesthetists completed pro-forma following all pediatric anesthesia procedures in which tracheal intubation was difficult. The collected information included: patient demographics; airway assessment; anesthetic technique and airway management strategies employed; and reasons for failure of intubation attempts. For the purposes of this audit, a difficult intubation was defined as an unsuccessful 2 attempts at direct laryngoscopy and intubation, causing a change in airway management technique, or a situation where direct laryngoscopy

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was not attempted i.e. due to limited mouth opening, therefore leading to an alternative airway management strategy.

Results

There were 50 cases which were assessed as difficult intubation. The cases were classified according to age group and the average weight per group was calculated. Ninety percent of the cases required intubation for surgical operations, and 10% underwent ENT/maxillofacial procedures. Eighty percent of the cases had an anticipated difficult intubation, with 40% having a history of previous difficult intubation (DI). Mallampati assessment was performed in 90% of the patients, with an increasing incidence in older children (Table 1).

The same airway assessment form was full filled for all children. Table 2 summarizes the features identified; the most common features were micrognathia (50%) and macroglossia (20%). Fifteen of the patients had a medical syndrome known to be associated with difficult airway management. Ten of these 15 patients had repeated operations during the study period. So, totally 20 of the cases in the study were associated with medical syndromes. Majority of cases had undergone abdominal surgeries.

Table 3 gives details of different airway devices used to intubate patients, the intubation view obtained, the number of intubation attempts, the rates of successful intubation and the reason for failure. Table 4 gives details of operation types that patients underwent.

Table 1. Patient Variables

Age	Number of DA cases (%)	Median weight (Min-Max) (kg)	Number of anticipated DI (%)	Number of previous DI (%)	Mallampati of grade 2/3/4 documented
2-5 years	12 (24%)	12 (10-15)	10 (25%)	0	0/0/7
5-14 years	24 (48%)	27 (20-40)	22 (55%)	15 (75%)	1/2/21
14-18 years	14 (28%)	60 (55-63)	8 (20%)	5 (25%)	0/1/13

DA: Difficult airway

DI: Difficult intubation

Table 2. Airway assessment features

Airway features	Number of cases (%)	Number of cases (%)	Mallampati score recorded	Mallampati score score 3/4	Previous history of DI
Micrognathia		25 (50%)	20 (80%)	17	20 (80%)
TMJ ankylosis		5 (10%)	5 (100%)	5	3 (60%)
Macroglossia		10 (20%)	10 (100%)	8	8 (80%)
Prominent teeth		7 (14%)	7 (100%)	7	7 (100%)
Short neck		3 (6%)	3 (100%)	3	2 (66.6%)

DI: Difficult intubation

TMJ: Temporomandibular Joint

Table 3. Advanced airway techniques and reason of failure

Advanced airway technique	Number of cases (%)	Intubation view Cormack/Lehane Score (1/2/3/4)	Number of intubation attempts (1/2/>3)	Number of successful Intubations (%)	Reason for failure		
					Poor view	Blood in airway	Unable to pass ETT
Oral FOB	25 (50%)	20/5/0/0	20/3/0	23 (92%)		2	
Nasal FOB	7 (14%)	7/0/0/0	2/3/0/0	5 (71%)		1	1
VL	8 (16%)	4/2/2/0	0/5/1/0	6 (75%)	2		
FOB via LMA	10 (20%)	10/0/0/0	10/0/0/0	10 (100%)			

FOB: Fiber optic bronchoscope

VL: Video laryngoscope

LMA: Laryngeal mask airway

Table 4. Surgery types

Age	ENT surgeries (%)	Bowed chest (%)	Removal of diseased intestines (%)	Various abdominal cancer surgery (%)
2-5 years	1 (2%)	0	3 (6%)	0
5-14 years	2 (4%)	3 (6%)	2 (4%)	25 (50%)
14-18 years	2 (4%)	2 (4%)	0	10 (20%)

ENT: Ear Nose Throat

All of the unsuccessful intubation procedures completed with surgical airway, tracheostomy. Before tracheostomy an LMA inserted than a pediatric surgeon performed the tracheostomy.

Of the 50 patients, 25 discharged to ward and 25 to the pediatric intensive care unit.

Discussion

This study presented a detailed information of the difficult airway management of pediatric patients over 2 years period in a large tertiary pediatric hospital, utilized by experienced pediatric anesthesiologists. Investigation of data reveals that 80 % of cases were anticipated with 40% having a history of difficult intubation, 20% having repeated operations within the study period. Of 50 patients, 24% were under 5 years. In our study a fiberoptic technique either nasal, oral or via laryngeal mask was used as the first advanced airway strategy in 84% of cases. Only in 6 cases the techniques chosen were unsuccessful and the strategy changed to a surgical airway. The most common reason of unsuccessful attempts was blood in the airway.

These findings highlight that difficult intubation is usually anticipated among the majority of cases. Pilsbury et al. reported their audit that difficult airway usually occurred in younger children because 60% of their difficult airway cases were under 6 years [7]. This is contrary with our results. The most possible reason for this result is the majority of children under 6 years undergoes inguinal hernia repair or circumcision in our clinic, so that their airway management consists of laryngeal mask airway. As a result, we didn't experience a lot of difficult airway cases at these years of age.

Heinrich et al performed a review of pediatric procedures and found that Mallampati score was documented in 66% of cases. In their study, as the age increased, the incidence of documentation increased, and reached to greater than 80% incidence in the children group over 6 year [8]. Our data is compatible to these results. In our study, 58.3% of children under 5 years had Mallampati documentation, while 100% in adolescents and school aged children. However, all the children should have a documented airway assessment preoperatively.

In a recent study [7], maxillofacial surgery was found to be associated with most of the difficult airway cases (17%). However, majority of cases in our study were abdominal surgeries.

Since its introduction in mid-1970s, pediatric fiber optic bronchoscopes (FOB) have been the gold standard for securing the airway when direct laryngoscopy is not possible [2]. Although there are a lot of benefits of FOB, the FOB has a steep learning curve and it is a fragile instrument that is expensive to repair, additionally a small amount of blood and secretions can worsen the quality of image. In our study mostly favored advanced airway technique was FOB (84%) either oral, nasal or via LMA. One study evaluating FOI in the difficult pediatric airway found a first attempt success rate of 80.4% and an overall rate of 95.6% [9]. In our study a first attempt success rate was 76% and overall rate was 94%. The success rate of oral FOB was higher than nasal FOB. Pediatric anesthesiologists in this study were more experienced in oral FOB.

Video laryngoscopes (VL) have been found to improve the laryngeal view when compared to direct laryngoscopy [10], but this doesn't mean that passing the ETT through the cords can be achieved easily [6]. In the current study although the glottic view was good with VL, generally intubation was successfully achieved in the second attempt. The increased intubation attempts may be associated with the fact that VL is a newer piece of equipment, so users are not as familiar with the technique as more established FOB.

Multiple techniques have been described for intubation via LMA in children [11-13]. The correct position of the laryngeal mask should be confirmed by the fiberoptic bronchoscope in the first step, and any necessary adjustments in position should be made. Once the cords have been correctly identified, intubation can be facilitated either by deepening the plane of anesthesia or by using a neuromuscular blocking drug after ensuring that the patients' lungs can be ventilated via the laryngeal mask [14]. During FOB, an attempted oral airway with chin lift position facilitate the FOB view but in patients with micrognathia, it is a very difficult situation to lift the mandibula. So LMA has an advantage to visualize the glottis easily in these situations. Hence, we administer FOB via LMA successfully in 10 patients. Furthermore, obtained glottic view with this technique was Cormach_Lehane grade 1 in all patients. Especially in specific difficult airway populations as Pierre-Robin FOB through a LMA might be superior to VL [15].

When we look at the last chance, surgical airway, in our study, we observed that the surgical airway was performed in "can't intubate" situations, though the mask ventilation was appropriate. As a result of this, securing the ventilation of the children via LMA was more suitable while performing a tracheostomy. Either ENT surgeon or a pediatric surgeon performed the surgical airway. In life-threatening situations when bag-mask ventilation and ventilation through Laryngeal Mask Airway (LMA) are not possible, the option to achieve the quickest possible oxygenation of the patient should be chosen, according to the available equipment and the physician's experience. However, it has to be taken into account that cricoid puncture and cricothyroidotomy are associated with high morbidity in children – the smaller the patient, the higher the risk [6-18]. In the current study, none of the patients required a cricothyroidotomy. It is authors' view that "can't intubate can't ventilate" scenario in pediatric population is not as common as in adults, but although it is a rare complication, special kits for emergence cricothyroidotomy should be ready at the operating rooms.

This report has some limitations. The present review describes a single institution's approach to the management of pediatric patients with a difficult airway over almost 2 years. Multiple center experiences would be instructive among pediatric anesthesiologists. The patient cohort didn't include every type of pediatric surgery due to a lack of pediatric plastic and reconstructive surgery department in our institution. In our opinion if maxillofacial procedures increase, anticipated difficult intubation and nasal FOB method will increase.

Conclusion

In conclusion, the intention behind this study was to create a screenshot of the various methods used when we were faced with a difficult airway management in pediatric population. Fiberoptic

intubation remains overall the best method whereas no method was 100% successful. As the majority of the patients had anticipated difficult airway, we have opportunity of planning surgical airway with other teams such as Ear-Nose-Throat and pediatric surgery.

Competing interests

The authors declare that they have no competing interest

Financial Disclosure

The financial support for this study was provided by the investigators themselves.

Ethical approval

This work has been approved by the Institutional Review Board

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