IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 6 Ver. IX (June. 2017), PP 87-95
www.iosrjournals.org

Anaesthetic Management During Removal of Airway Foreign Body in Children: A Prospective Observational Study

*Monika Mahajan[1],Som Raj Mahajan[2],Preethy J. Mathew[3],Usha K Chaudhary[1], Rajesh Chaudhary[2]

[1]*Department of Anaesthesia, Dr. Rajendra Prasad Govt. Medical College, Tanda, Kangra, H.P. India*
[2]*Department of surgery, Dr. Rajendra Prasad Govt. Medical College, Tanda, Kangra, H.P. India*
[3]*Department of Anaesthesia, P.G.I.M.E.R, Chandigarh, India*

**Corresponding author: *Monika Mahajan*

Abstract: *Aspiration of foreign body (FB) is a life threatening situation in children. Prompt and early foreign body (FB) removal by rigid bronchoscopy under general anaesthesia is essential for reducing the complications and mortality. This study was conducted to observe the preoperative presentation, anaesthetic management and post-procedure morbidity and outcomes of children undergoing rigid bronchoscopic removal of inhaled foreign bodies under general anaesthesia.*

Keywords: *Foreign body aspiration, airway foreign body, inhalational anaesthesia, intravenous anaesthesia.*

I. Introduction

Aspiration of foreign body (FB) is a life threatening situation in children. Asphyxiation from inhaled foreign bodies is among the five leading causes of accidental deaths in children[1]. Approximately 80 percent of FB aspirations occur in children younger than three years of age, with peak incidence occuring between one and two years of age[2]. Children are more prone for FB aspiration at this age, because most children are able to stand and move around, are apt to explore their world via the oral route, and also have the fine motor skills to put a small object into their mouths, but they do not yet have molars to chew the food adequately. Young children are also particularly vulnerable to foreign body (FB) aspiration because of the smaller diameter of their airway, which is prone to obstruction. The effects of foreign body (FB) inhalation can vary from nonspecific symptoms of coughing, wheezing, fever and dyspnoea to life threatening airway obstruction and death. Prompt and early foreign body (FB) removal by rigid bronchoscopy under general anaesthesia is essential for reducing the complications and mortality. It is a brief but challenging procedure for the anaesthesiologist and endoscopist. Besides sharing the airway with surgeon, anesthesiologist has to maintain adequate depth of anaesthesia to minimize bucking, coughing and straining during the instrumentation. They have to maintain stable hemodynamics and ensure rapid return of airway reflexes at the end of procedure[3]. Number of anaesthetic techniques have been used for airway endoscopy in children. The procedure is performed under general anaesthesia with either spontaneous respiration or controlled mechanical ventilation (CMV) with or without muscle relaxant, each having its own merits and demerits. CMV after using a muscle relaxant allows more rapid control of airway, decrease chances of aspiration of gastric contents and gives better patient immobility[4-7]. However, positive pressure ventilation increases the risk of dislodging an unstable proximal FB leading to complete airway obstruction. In addition, there is also the risk of barotrauma with positive pressure ventilation. Therefore, several case series have reported use of spontaneous ventilation(SV)[3,8–12] during anaesthesia in these children leading to adequate ventilation/perfusion ratio, minimal chances of barotrauma while maintaining adequate depth of anaesthesia. Bronchoscopy may be associated with hypoxic events caused by sedation, partial airway obstruction, abnormal distribution of ventilation and reflex response to bronchoscopy and lavage. Post-bronchoscopy complications include broncho-laryngospasm, arterial desaturation, and the need for tracheal re-intubation.

II. Material And Methods

This study was conducted at the Department of Anaesthesia and Intensive care and Department of Paediatric Surgery, Advanced Paediatric Centre at PGIMER, Chandigarh during the study period from August 2014 to July 2015. With this study we intended to observe the anaesthetic management of the children undergoing rigid bronchoscopy for the foreign body removal from the airway. After approval by our institutional ethics committee and obtaining informed consent of the parents, an observational study was conducted to evaluate the preoperative presentation of 71 children with positive bronchoscopy for removal of airway FB aspiration. One child underwent bronchoscopy twice in two separate admissions to retrieve the same FB, so number of bronchoscopies included in our analysis were 72 in 71 children. Pre-operatively, relevant

clinical information such as age, gender, weight, time of suspected aspiration, mode of aspiration, signs and symptoms, duration of clinical picture, FB type, FB location and other comorbidities were evaluated. Preoperative AVPU (Alert, responds to voice, responds to pain, unresponsive) paediatric response scale, chest X-ray and other relevant investigations were also noted. Bronchoscopy procedure was performed in emergency or elective operation theatre under general anaesthesia as decided by the emergency paediatric surgery team. The choice and nature of anaesthetic agents and mode of ventilation was decided by anaesthetist depending on the clinical presentation. All the children were monitored continuously for heart rate, ECG, respiratory rate, pulse oximetery and non-invasive blood pressure. The details of anaesthetic management and monitoring were collected. In addition, the time between the suspected aspiration and removal of foreign body, intra-operative ventilation strategy, drugs used, type of bronchoscope used, duration of procedures were recorded. Peri-operative adverse events including movement during procedure, hypoxemia, breath-holding, laryngospasm, bleeding and postoperative airway obstruction, pneumothorax, and the need for re- intubation/critical care and duration of hospital stay were also recorded. The postoperative outcomes, changes in chest X-ray and time of discharge, were also noted. Hypoxia was defined as pulse oximetry saturation of less than 90%. Tachycardia and tachypnoea were defined according to age. Rescue interventions like endotracheal intubation, oxygenation, suction, chest physiotherapy, drugs and ventilatory support were provided in cases of adverse events like laryngospasm, hypoxia, bradycardia, pneumothorax, and mucosal bleeding.

III. Observations And Results

Out of the 71 patients studied, 40 (55.5%) bronchoscopies were done during winter months in November, December and January. The aspiration of FB was clearly witnessed by an adult in 58 (81.7%) children including the child that presented twice for bronchoscopy. In another 4 (5.6%) children, FB was suspected based on circumstantial evidences at the time of onset of symptoms, for example, child was playing with the suspected FB and the adult recollected the sudden onset of symptoms from a definite point of time. Therefore, we have categorized these 4 children as strongly suspected cases based on circumstantial history. There was no definite history of witnessing or a strong reason to suspect aspiration of FB in remaining 9 (12.6%) children. However bronchoscopy was done either to rule out a FB or due to suspicion of FB based on the clinical presentation. The mean age of distribution of all children was 27.32 ± 26.85 months (range: 6 months to 120 months). 57 (80.3%) children were less than 3 years of age, and 14 (19.7%) children were more than 3 years of age. Majority of aspirations were found in male patients (Table 1).

Table 1: Demographic data of patients

Variable	Total Children (n=71)	Actually witnessed aspiration (n=58)	Strongly suspected of aspiration (n=4)	Foreign body aspiration not witnessed (n=9)
Age (months)(mean±SD)	27.32±26.85	26.10±25.98	36±33.94	31.33±31.68
Number of children with age less than 3 years (%)	57 (80.3%)	47 (81.0%)	3 (75.0%)	7 (77.8%)
Number of children more than 3years of age (%)	14 (19.7%)	11 (19.0%)	1 (25.0%)	2 (22.2%)
Sex				
Male (%)	50 (70.4%)	41 (70.7%)	3 (75.0%)	6 (66.7%)
Female (%)	21 (29.6%)	17 (29.3%)	1 (25.0%)	3 (33.3%)

The average interval between aspiration of a foreign body and admission to PGIMER was 4402.82±16726.73 minutes with a range of 85 to 56904 minutes and median of 1404 minutes. Amongst the 71 children, 31 (43.6%) children presented within 24 hours of aspiration. One child had bronchoscopy twice at PGIMER on two separate occasions for the same FB aspiration. Playing was the most common activity during aspiration of FB in 34 (47.8%) children. Most common suspected location of FB was in the right bronchus in 39 (54.9%) children. Vegetable foreign bodies were suspected in 53 (74.6%) children, among which nuts were

most commonly suspected i.e in 39 (54.9%) cases. After admission the children were taken up for bronchoscopic removal of foreign body at an interval of 722±1379.79 minutes (range: 12 minutes to 8482 minutes) with a median of 456 minutes. During pre-anaesthetic checkup, we found that cough was most common presenting symptom in 49 (68.1%) cases, followed by noisy breathing/ wheezing in 26 (36.1%) children (table 2). Air entry was decreased in 53 (73.6%) children, tachypnoea (increased respiratory rate according to age) was present in 36 (50.0%) children and tachycardia (increased heart rate according to age) was present in 50 (69.4%) children. Chest X-ray showed hyperinflation in 44 (61.1%) cases (table 3).
One child who was responding to voice at admission deteriorated to become unresponsive due to cardiorespiratory arrest and was revived after 2 cycles of CPR, intubated and shifted to operation theatre on ionotropes and on assisted ventilation.

Table 2: Pre-anaesthetic clinical presentation data

Variable	Total (n=72)	Actually Witnessd aspiration (n=59)	Strongly suspected of aspiration (n=4)	Foreign body aspiration not witnessed (n=9)
Sign and symptoms				
Symptoms				
Cough	49 (68.1%)	38 (64.4%)	3 (75%)	8 (88.9%)
Noisy breathing /wheezing	26 (36.1%)	24 (40.7%)	0	2 (22.2%)
Fever	13 (18.1%)	11 (18.6%)	0	2 (22.2%)
History of choking	12(16.7%)	9 (15.3%)	2(50.0%)	1 (11.1%)
Irritable	5 (6.9%)	5 (8.5%)	0	0
Cyanosis /bluishness	5 (6.9%)	5 (8.5%)	0	0
Vomiting	4 (5.6%)	4 (6.8%)	0	0
Excessive crying	4 (5.6%)	3 (5.1%)	0	1(11.1%)
Signs				
Subcostal retraction	23 (31.9%)	19 (32.2%)	2 (50.0%)	2 (22.2%)
Nasal flaring	11 (15.3%)	8 (13.6%)	1 (25.0%)	2 (22.2%)
Intercostal retraction	8 (11.1%)	7 (11.9%)	1 (25.0%)	0
Accessory muscle use	1 (1.4%)	1 (1.7%)	0	0
Suprasternal retraction	3 (4.2%)	3 (5.1%)	0	0
Increased work of breathing	43 (59.7%)	36 (61.0%)	3 (75.0%)	4 (44.4%)
Auscultation				
Crepts	28 (38.9%)	21 (35.6%)	3 (75.0%)	4 (44.4%)
Wheeze	22 (30.6%)	19 (32.2%)	1 (25.0%)	2 (22.2%)
Crepts+ wheeze	9 (12.5%)	7 (11.9%)	0	2 (22.2%)
Chest expansion /air movement				
Air entry decreased	53 (73.6%)	41 (69.5%)	4 (100%)	8 (88.9%)
Hyper resonant chest	1 (1.4%)	0	0	1 (11.1%)
Chest X-ray				
Hyperinflation	44 (61.1%)	35 (59.3%)	2 (50.0%)	7 (77.8%)
Foreign body visualized	8 (11.15)	6 (10.2%)	1 (25.0%)	1 (11.1%)
Consolidation	2 (2.8%)	1 (1.7%)	0	1 (11.1%)
Collapselung	5 (6.9%)	5 (8.55)	0	0
Pneumothorax, Pneumomediastinum and Subcutaneous emphysema	1(1.4%)	1 (1.7%)	0	0

All bronchoscopies were done under controlled ventilation. Induction was done with inhalational agents using sevoflurane alone in 36 (50.0%) cases and a combination of intravenous and inhalational agent was used in 27 (37.5%) patients. Intravenous induction with propofol was done in 9 (12.5%) patients (table 3). Short acting opioid, fentanyl was used in 35 (48.6%) cases whereas morphine was used in 3 (4.2%) cases. No narcotics were used in the remaining 34 (47.2%) children. Succinylcholine alone was the most commonly used muscle relaxant agent in 47 (65.3%) cases and succinylcholine followed by atracurium was used in 19 (26.4%) cases. Atracurium alone was used in 6 (8.3%) patients. Maintenance of anaesthesia was done with only inhalational agents - sevoflurane or isoflurane in 24 (33.3%) cases whereas combination of inhalational and intravenous agent was used in 38 (52.8%) cases. Intravenous anaesthetic technique was used for maintenance of anaesthesia in only 10 (13.9%) cases. (Table 4).

Table 3: Intraoperative anaesthetic drug data for induction of anaesthesia

Drugs used	Total (n=72)	Actually Witnessed aspiration (n=59)	Strongly suspected of aspiration (n=4)	Foreign body aspiration not witnessed (n=9)
Controlled mode of ventilation: controlled	72 (100%)	59 (100%)	4 (100%)	9 (100%)
Induction of anaesthesia				
Sevoflurane only	36 (50.0%)	29 (49.2%)	2 (50.0%)	5 (55.6%)
Propofol only	9 (12.5%)	6 (10.2%)	2 (50.0%)	1 (5.3%)
Combination of propofol and sevoflurane	25 (34.7%)	22 (37.3%)	0	3 (33.3%)
Combination of Thiopentone and sevoflurane	1 (1.4%)	1 (1.7%)	0	0
Combination of ketamine and sevoflurane	1 (1.4%)	1 (1.7%)	0	0
Opioids				
Fentanyl	35 (48.6%)	26 (44.1%)	3 (75%)	6 (66.7%)
Morphine	3 (4.2%)	2 (3.4%)	1 (25%)	0
No opioid	34 (47.2%)	31 (52.5%)	0	3 (33.3%)
Muscle relaxant				
Succinylcholine	47 (65.3%)	39 (66.1%)	1 (25.0%)	7 (77.8%)
Atracurium	6 (8.3%)	5 (8.5%)	0	1 (11.1%)
Succinylcholine+atracurium	19 (26.4%)	15 (25.4%)	3 (75.0%)	1 (11.1%)

Table 4: Intraoperative anaesthetic drug data for maintenance of anaesthesia

Drugs used	Total (n=72)	Actually Witnessed aspiration (n=59)	Strongly suspected of aspiration (n=4)	Foreign body aspiration not witnessed(n=9)
Maintenance of anaesthesia				
Sevoflurane only	22 (30.6%)	18 (30.5%)	1 (25.0%)	3 (33.3%)
Isoflurane only	2 (2.8%)	3 (3.4%)	0	0
Propofol bolus only	5 (6.9%)	5 (8.5%)	0	0
Propofol infusion only	5 (6.9%)	3 (5.1%)	2 (50.0%)	0
Combination of Sevoflurane and propofol	34 (47.2%)	28 (47.5%)	0	6 (66.7%)
Combination of sevoflurane and thiopentone	1 (1.4%)	0	1 (25.0%)	0
Combination of isoflurane and propofol	3 (4.2%)	3 (5.1%)	0	0
Reversal from neuromuscular blocade				
Spontaneous recovery from succinylcholine	47 (65.3%)	39 (66.1%)	1 (25.0%)	7 (77.8%)
Neostigmine+glycopyrrolate	23 (31.9%)	18 (30.5%)	3 (75.0%)	2 (22.2%)
Unreversed	2 (2.8%)	2 (3.4%)	0	0

Vegetable foreign bodies were most common, i.e. in 59 (83.1%) cases, predominantly peanuts in 41 (57.7%) cases. Among non-vegetable foreign bodies, pen cap was found in 3 (4.2%) children. Foreign bodies were located predominanty in right bronchus in 37 (52.1%) children (table 5). Number of attempts to remove FB ranged from 1 to 9. Number of insertion of bronchoscope ranged from 1 to 8 .

Table 5: Intraoperative foreign body data

Variable	Total (n=71)	Actually Witnessed aspiration(n=58)	Strongly suspected of aspiration (n=4)	FB aspiration Not witnessed (n=9)
Site of impacted FB				
At carina	8 (11.3%)	7 (12.1%)	0	1 (11.1%)
At glottis	2 (2.8%)	2 (3.4%)	0	0
Left bronchus	19 (26.8%)	16 (25.9%)	1 (25.0%)	3 (33.3%)
Right + left bronchus	2 (2.8%)	2 (3.4%)	0	0
Right bronchus	37 (52.1%)	30 (51.7%)	3 (75.0%)	4 (44.4%)
Trachea	3 (4.2%)	2 (3.4%)	0	1 (5.3%)
Type of FB removed				
Vegetable	60 (84.5%)	50 (86.2%)	3 (75%)	7 (77.8%)
Peanut	42 (59.1%)	34 (58.6%)	3 (75.0%)	5 (55.5%)

Almond	4 (5.6%)	4 (6.9%)	0	0
Pomegranate Seed	1 (1.4%)	1 (1.7%)	0	0
Betel Nut	1 (1.4%)	0	0	1 (11.1%)
Cashewnut	1 (1.4%)	1 (1.7%)	0	0
Chana	7 (9.9%)	7(12.1%)	0	0
Chicken Bone	1 (1.4%)	1 (1.7%)	0	0
Coconut pieces	1 (1.4%)	0	0	1 (11.1%)
Grass	1 (1.4%)	1 (1.7%)	0	0
Seed	1 (1.4%)	1 (1.7%)	0	0
Non-vegetable	11 (15.4%)	8 (13.7%)	1 (25.0%)	2 (22.2%)
Ball Pencap	3 (4.2%)	2 (3.4%)	0	1 (11.1%)
Whistle	2 (2.8%)	2 (3.4%)	0	0
Mud	1 (1.4%)	1 (1.7%)	0	0
Plastic	1 (1.4%)	0	1(25.0%)	0
Nail Polish Brush	1 (1.4%)	1 (1.7%)	0	0
Light emission diode Bulb	1 (1.4%)	1 (1.7%)	0	0
Brick Pieces	1 (1.4%)	1 (1.7%)	0	0
Metallic Pin	1 (1.4%)	0	0	1(11.1%)
Numberof attempts of removal of FB	Median 2 (Range:1 to 9)	Median 2 (Range:1 to 9)	Median 2 (Range:1 to 3)	Median 3 (Range: 2 to 4)
Number of insertion of bronchoscope	Median 2 (Range:1 to 8)	Median 2 (Range:1 to8)	Median 2 (Range:2 to 4)	Median 2 (Range:2 to 3)

Desaturation was observed in 18 (25.0%) children, and airway mucosal bleeding was observed in 14 (19.4%) children. Movement during procedure was found in 8 (11.1%) cases, whereas airway edema was found in 6 (8.3%) cases. Both bradycardia and bronchospasm were found in 2 (2.8%) cases and laryngospasm was found in only 1 (1.4%) case (Table 6). The combination of inhalational and intravenous agent for maintenance of anaesthesia was a significant factor for desaturation (p=0.050) whereas maintenance of anaesthesia with inhalational agents only was least associated with desaturation. There was no statistically significant relationship between complications like desaturation, airway mucosal bleeding, movement during procedure, airway oedema, bradycardia, bronchospasm, laryngospasm with factors like duration of presentation of FB, type of FB and type of anaesthetic agents used for induction.

Table 6: Incidence of Intraoperative complications in all cases.

Intraoperative complication	Total number Of cases (n =71)	Actually Witnessed aspiration (n=58)	Strongly Suspected of aspiration (n=4)	Foreign body aspiration not witnessed (n=9)
Desaturation	18 (25.3%)	15 (25.9%)	2(50.0%)	1 (11.1%)
Airway mucosal Bleeding	14 (19.7%)	13 (22.4%)	1(25.0%)	0
Movement during procedure	8 (11.3%)	5 (8.6%)	1(25.0%)	2 (22.2%)
Airway oedema	6 (8.4%)	6 (10.3%)	0	0
Bradycardia	2 (2.8%)	2 (3.4%)	0	0
Bronchospasm	2 (2.8%)	2 (3.4%)	0	0
Laryngospasm	1 (1.4%)	1 (1.7%)	0	0

After removal of FB 34 (47.2%) cases were ventilated with mask till they became alert and had recovery from muscle relaxant. Planned endotracheal intubation followed by extubation on operation table was done in another 32 (44.4%) cases. The remaining 6 (8.3%) patients, including the three patients who were received intubated preoperatively were not extubated, they were kept postoperatively on assisted ventilation for average of 1362.5$\pm$726.56 minutes and ICU stay of 4413.16$\pm$2686.26 minutes. (Table 7). Postoperatively one child died, who had preoperative history of cardiac arrest, was revived after 2 cycles of CPR, shifted in operation theatre on ionotropes, and on assisted ventilation. Intraoperatively chana piece was removed from right bronchus.

Table 7: Postoperative outcomes

Airway	Total cases (n=72)	Actually Witnessed aspiration (n=59)	Strongly Suspected of aspiration (n=4)	Foreign body aspiration not witnessed (n=9)
Death	1 (1.4%)	1 (1.7%)	0	0
Postoperative elective ventilation	6(8.3%)	5 (8.4%)	1(25%)	0
Duration of Postoperative elective Ventilation (in minutes)	1362.5±726.50	4702.80±2896.70	1210	0
Duration of Postoperative ICU Stay (in minutes)	4413.16±2686.26	1393.00±808.00	2965	0

IV. Discussion

Among 71 children enrolled in our study, 40 (56.3%) children presented during winter months in November, December and January. This may reflect the eating habits of children in this part of country in winters as also observed by Gulati et al[13]. Majority of children 57 (80.3%) presented were below 3 year of age, with mean age of 27.32 months. Similar observations were made in other studies[14,15,16]. Children in this age group are more vulnerable because of development of ability to stand and move around, tendency to use their mouth to explore the surroundings, lack molars, incomplete coordination between chewing and swallowing and lack of close supervision. FB was predominately present in male children 50 (70.4%) as corroborative with other studies[14,15,17]. Although there was clear witness of aspiration of FB by an adult in 58 (81.7%) children and another 4 (5.6%) children had circumstantial evidence in our study, aspiration of FB was not witnessed in 9 (12.6%) children. Gang et al (2012) had observed clear witnessed history in 73.8% cases while 26.2% did not have clear history of FB aspiration[16], although Naragund et al (2014) noted definitive history only in 36.4% cases, while 65.6% cases were unwitnessed[17]. So even if unwitnessed, a diagnosis of FB should be kept in mind when dealing with respiratory diseases if other sign and symptoms of FB aspiration is present. Physical activity like playing 24 (33.8%), eating 22 (31.0%) were most common activities during aspiration as supported by Foltran et al[18]. The propensity of children to talk, laugh, and run while chewing also increases the chance that a sudden or large inspiration may occur with food in the mouth. In our study there were 31 (43.7%) children who presented within 24 hours and 40 (56.3%) children presented after 24 hours. Tomaski et al[19] observed 60% presentation whereas Maddali et al[20] observed 44% presentation within 24 hours. Delayed diagnosis of FB may be due to variable clinical history and clinical findings, delay in seeking treatment by parents and misdiagnosis by clinicians. Since ours is a tertiary care centre in this region and most of these cases are referred from other hospitals, delay in referral and transportation also play a role in delayed presentation of these children to this institute. In our study 36 (50.7%) cases were referred from other hospital. FB aspiration is a life threatening situation, so early diagnosis and treatment plays a crucial role in the management of these children. Vegetable foreign bodies were found in 60 (84.5%) cases, although these were suspected in 53 (74.6%) cases based on history. Peanut was the most common vegetable FB in 42 (59.1%). Fidkowski et al[14], Boufersaoui et al[15], Kaur et al[21] had similar finding. Groundnut/peanut was the most common airway FB in winter months because it is quite cheap and commonly eaten commodity and is usually given to appease crying children by their ignorant parents realising little of its potential of airway aspiration.

Among 12 (16.9%) non-vegetable foreign bodies, pen caps were removed in 3 (4.2%) children. Type of FB aspirated reflects the eating habits of people around the world like peanuts in China, dry pumpkin seeds in Greece, watermelon seeds in Egypt, head scarf pins in Turkey are most commonly aspirated[22,23,24]. Vegetable foreign bodies absorb water and subsequently change partial obstruction to complete obstruction. They also release chemicals that lead to chemical bronchitis with fever and chest infection. Non vegetable foreign bodies produce few signs and symptoms and may present later until they become obstructive causing emphysema or atelectasis. In our study, FB was mostly found in right bronchus in 39 (54.9%) children as compared to left bronchus in 21(29.6%) children. Sinha et al[24], Fidkowski et al[14], Kaur et al[21] had similar findings. Whereas Naragund et al found no significant difference between FB aspiration in right and left bronchus[17], Liu et al found predominance of FB aspiration in left bronchus in 60% children[25]. Most common presenting symptom in our study was cough in 49(68.1%) cases, followed by noisy breathing/ wheeze in 26(36.1%) cases. Increased work of breathing was present in 43(59.7%) cases. Naragund et al found cough in 90.9% cases, wheeze in 90.9% and respiratory distress in 72.7% cases[17]. Similarly Kaur et al observed cough in 92% cases and respiratory distress in 80% cases and wheeze in 64% cases[21]. A history of cough is highly sensitive but not very specific for aspiration of foreign body as observed by Fidkowski et al[14]. They also found that a history of cyanosis and stridor is very specific for foreign body aspiration but is not very sensitive[14]. Air entry was

decreased in 53 (73.6%) cases. Similar finding was observed by Naragund et al[17] in 72.7% children and Kaur et al[21] in 72% children. The classical triad of presentation –cough, wheeze and decreased air entry should raise the suspicion of airway foreign body in children presenting with respiratory distress. Chest X-ray is the most common and readily available investigation to confirm the diagnosis. In our study we observed hyperinflation in 44 (61.1%) children as the most common finding that is consistent with review done by Fidkowski et al[14]. Besides this a chest X-ray may help in identifying a radiopaque FB and location of FB, identify other potential causes of symptoms. Therefore, hyperinflation on X-ray along with clinical triad produces a strong suspicion in a male child of less than three years age. There was a delay of approximately 12 hours between admission and procedure. Since most of the children were clinically stable, so bronchoscopic removal of airway FB was performed on the next available day time operating list rather than doing it late at night. The nil per oral (NPO) status also plays a role in delay, as the stable children were taken after the recommended NPO hours. All this allowed optimal conditions for manipulation of paediatric airway by experienced paediatric surgeon and anaesthesiologist. Anaesthesiologists share the management of a potentially obstructed airway with surgeon, so a clear communication and good cooperation is essential. Although there are several anaesthetic techniques which are effective for managing children with FB aspiration, there is no consensus from the literature as to which technique is optimal[26]. In our study controlled ventilation was used in all the cases. Controlled ventilation by using muscle relaxant provides better patient immobility, rapid control of airway and even depth of anaesthesia. Positive pressure ventilation also decreases chances of atelectasis, improves oxygenation and decreases airway resistance when bronchoscope is used. Cohen et al recommended that once it is established that ventilation is possible, a relaxant based technique should be used[27]. An induction with spontaneous ventilation decreases the risk of converting partial proximal obstruction to a complete obstruction. It also allows continuous ventilation during removal of FB and adequacy of the patient airway can be rapidly assessed after removal of FB. However, Soodan et al observed significantly increased incidence of coughing and bucking, increased time for induction of anaesthesia and prolonged recovery time from anaesthesia in spontaneous ventilation with halothane group as compared with controlled ventilation group using halothane or thiopentone[4]. Therefore, they recommended the use of controlled ventilation with muscle relaxants and inhalational anaesthesia for rigid bronchoscopy. Chen et al also found that intraoperative desaturation, body movements, hypoxemia, breath holding,and postoperative laryngospasm was more common with spontaneous ventilation as compared to controlled ventilation[5]. Litman et al[7] and Soodan et al[4] found that cases initially started with spontaneous ventilation had to be converted to controlled ventilation due to increased intraoperative complications. Anaesthesiologists and surgeons in our institute are more comfortable with controlled ventilation considering the morbidity and mortality associated with the procedure, as use of controlled ventilation with inhalational or intravenous anaesthesia provides adequate and even depth of anaesthesia for rigid bronchoscopy. In our study induction with sevoflurane only was done in half of the cases, whereas propofol was used in 9 (12.5%) cases. Combination of propofol and sevoflurane was used in 27 (37.5%) cases. Anaesthesia was maintained with inhalational agents like sevoflurane and isoflurane only in 24 (33.3%) cases, with propofol only in 10 (13.9%) cases and combination of intravenous and inhalational agents was used in 38 (52.8%) cases. Sevoflurane is preferred agent because of nonirritant nature, rapid onset and more stable hemodynamics. In a study by Liao Ren et al, they concluded that sevoflurane used for induction and maintenance provides, faster induction and recovery, more stable haemodynamics and respiration and higher incidence of excitement in children undergoing airway FB removal under spontaneous breathing as compared to total intravenous anesthesia using propofol and remifentanil[28]. However due to constant leak around bronchoscope and hypoventilation, inhaled anaesthetic agent may be associated with inadequate depth of anaesthesia. Besides this it is also associated with pollution of operation theater due to leak around the bronchoscope and the high flow required for ventilation.

Whereas benefit of an intravenous anaesthetic agent is that it provides constant level of anaesthesia irrespective of ventilation. However Chen et al observed that spontaneous ventilation with total intravenous anaesthesia is associated with higher incidence of breath holding, body movement, laryngospasm as compared to an inhaled anesthesia[5]. Maddali et al also concluded that inhalational agent was associated with less postprocedural complications[20]. Opioids like fentanyl was used in 35 (48.6%) cases and morphine was used in 3 (4.2%) cases. Opioids provide analgesic effect, decrease the cough reflex and decrease requirement of anaesthetic agent for maintenance of depth of anaesthesia. Opioids were not used in 34 (47.2%) cases, which may had contributed to inadequate depth of anaesthesia leading to increased intraoperative complications. Short acting muscle relaxants like succinylcholine (65.6%) and atracurium were used to prevent bucking, straining and movements during the procedure. In our study we have found that a combination of inhalational and intravenous agents for maintenance of anaesthesia was a significant factor for intraoperative desaturation ($p=0.050$) whereas maintenance of anaesthesia with inhalational agents only was least associated with desaturation. Maintenance of anaesthesia with combination of inhalational and intravenous agents during bronchoscopy lead to inadequate depth of anaesthesia because leakage of gas from the proximal end of the

bronchoscope was supplemented with less than recommended doses of propofol required for maintenance, leading to increased incidence of desaturation. There was no statistically significant relationship between complications like desaturation, airway mucosal bleeding, movements during procedure, airway oedema, bradycardia, bronchospasm, and laryngospasm with factors like duration of presentation after ingestion of FB, type of FB and type of anaesthetic agents used for induction. Maddali et al noted that age, the type of FB and duration after suspected or witnessed inhalation before bronchoscopy had no relationship to the occurrence of complications, but he observed that the use of intravenous agents rather than inhalation agents for induction of anesthesia and duration of bronchoscopy beyond 30 minutes was associated with a significant increase in complications[20]. Pinzoni et al concluded that perioperative complications like bronchospasm, bleeding and desaturation were not related with either the volatile or intravenous agent or the duration of surgery[12] .There was single mortality (1.4%) in our study. Kaur et al[21] had observed 2% mortality and Sahin et al[29] found mortality of 0.8%.

V. Conclusion

Tracheobronchial foreign bodies constitute a serious and potentially fatal situation usually occurring in children. Rigid bronchoscopy should be done in all the children with classical signs and symptoms, even if not witnessed.. Maintance of anaesthesia with inhalational anaesthetics agents during the bronchoscopy is associated with least amount of complications while removing the airway foreign bodies.The risk of serious complications caused by retained foreign body outweighs the low morbidity associated with rigid bronchoscopy done for removal of airway foreign bodies.

References

[1]. Bluestone CD, Stool SE, Alper CM, Arjmand EM. Pediatric otolaryngology. 4th ed. Elsevier Health Science; 2002.Chapter 71. Foreign bodies of pharynx and esophagus; p.1324.

[2]. Shivakumar AM, Naik AS, Prashanth KB, Shetty KD, Praveen DS. Tracheobronchial foreign bodies. Indian J Pediatr. 2003;70:793-7.

[3]. Moustafa MA. Nebulized lidocaine alone or combined with fentanyl as a premedication to general anesthesia in spontaneously breathing pediatric patients undergoing rigid bronchoscopy. Paediatr Anaesth. 2013;23:429-34.

[4]. Soodan A, Pawar D, Subramanium R. Anesthesia for removal of inhaled foreign bodies in children. Paediatr Anaesth. 2004;14(11):947–52.

[5]. Chen L, Zhang X, Li S, Liu Y, Zhang T, Wu J. The risk factors for hypoxemia in children younger than 5 years old undergoing rigid bronchoscopy for foreign body removal. Anesth Analg. 2009;109(4):1079–84.

[6]. Li S, Liu Y, Tan F, Chen J, Chen L. Efficacy of manual jet ventilation using Manujet III for bronchoscopic airway foreign body removal in children. Int J Pediatr Otorhinolaryngol. 2010;74(12):1401–4.

[7]. Litman RS, Ponnuri J, Trogan I. Anesthesia for tracheal or bronchial foreign body removal in children: an analysis of ninety-four cases. Anesth Analg. 2000;91(6):1389–91.

[8]. Shen X, Hu C-B, Ye M, Chen Y-Z. Propofol-remifentanil intravenous anesthesia and spontaneous ventilation for airway foreign body removal in children with preoperative respiratory impairment. Paediatr Anaesth. 2012; 22(12):1166–70.

[9]. Dutta A, Shouche S. Study of efficacy of anaesthesia with propofol and fentanyl for rigid bronchoscopy in foreign body bronchus removal in children. Indian J Otolaryngol Head Neck Surg. 2013;65(3):225–8.

[10]. Cai Y, Li W, Chen K. Efficacy and safety of spontaneous ventilation technique using dexmedetomidine for rigid bronchoscopic airway foreign body removal in children. Paediatr Anaesth. 2013;23(11):1048–53.

[11]. Chen K-Z, Ye M, Hu C-B, Shen X. Dexmedetomidine vs remifentanil intravenous anaesthesia and spontaneous ventilation for airway foreign body removal in children. Br J Anaesth. 2014;112(5):892–7.

[12]. Pinzoni F, Boniotti C, Molinaro SM, Baraldi A, Berlucchi M. Inhaled foreign bodies in pediatric patients: Review of personal experience. Int J Pediatr Otorhinolaryngol. 2007;71(12):1897–903.

[13]. Gulati SP, Kumar A, Sachdeva A AA. Groundnut as the commonest foreign body of tracheobronchial tree in winter in Northern India. An analysis of fourteen cases. Indian J Med Sci. 2003;57(6):244–8.

[14]. 14 Fidkowski CW, Zheng H, Firth PG. The anaesthetic considerations of tracheobronchial foreign bodies in children: A literature review of 12,979 cases. Anesth Analg. 2010;111:1016-25.

[15]. Boufersaoui A, Smati L, Benhalla KN, Boukari R, Smail S, Anik K, et al. Foreign body aspiration in children: experience from 2624 patients. Int J Pediatr Otorhinolaryngol. 2013;77(10):1683–8.

[16]. Gang W, Zhengxia P, Hongbo L, Yonggang L, Jiangtao D, Shengde W, et al. Diagnosis and treatment of tracheobronchial foreign bodies in 1024 children. J Pediatr Surg. 2012;47(11):2004–10.

[17]. Naragund AI, Mudhol RS, Harugop AS, Patil PH, Hajare PS, Metgudmath VV. Tracheo-bronchial foreign body aspiration in children: a one year descriptive study. India J Otolaryngol Head Neck Surg. 2014;66 (SUPPL.1):180–5.

[18]. Foltran F, Ballali S, Passali FM, Kern E, Morra B, Passali GC, et al. Foreign bodies in the airways: A meta-analysis of published papers. Int J Pediatr Otorhinolaryngol. Elsevier Ireland Ltd; 2012;76 (SUPPL. 1):12–9.

[19]. Tomaske M, Gerber AC, Weiss M. Anesthesia and periinterventional morbidity of rigid bronchoscopy for tracheobronchial foreign body diagnosis and removal. Paediatr Anaesth. 2006;16(2):123–9.

[20]. Maddali MM, Mathew M, Chandwani J, Alsajwani MJ, Ganguly SS. Outcomes after rigid bronchoscopy in children with suspected or confirmed foreign body aspiration: a retrospective study. J Cardiothorac Vasc Anesth.2011; 25(6):1005–8.

[21]. Kaur K, Sonkhya N, Bapna AS. Foreign bodies in the tracheobronchial tree: a prospective study of 50 cases. Indian J Otolaryngol Head Neck Surg.2002; 54(2):30–4.

[22]. Daniilidis J, Symeonidis B, Triaridis K, Koulolas A. Foreign body in the airways : A review of 90 cases. Arch Otolaryngol Head Neck Surg. 1977;103 : 570-573.

[23]. Gaafar H, Abdet M Ayem, Talaat M. The value of X-ray examination in the diagnosis of tracheobronchial foreign bodies in infants and children. ORL J Otorhinolaryngol Relat Spec. 1982;44:340–8.

[24]. Sinha V, Memon R, Gupta D, Prajapati B, Bhat V, More Y. Foreign body in tracheobronchial tree. Indian J Otolaryngol Head Neck Surg. 2007;59:211–4.
[25]. Liu J, Xiao K, Lv X. Anesthesia and ventilation for removal of airway foreign bodies in 35 infants. Int J Clin Exp Med. 2014;7(12):5852–5856.
[26]. Farrel PT. Rigid bronchoscopy for foreign body removal: anesthesia and ventilation. Pediatr Anesth 2004; 14: 84–89.
[27]. Cohen SR, Herbert WI, Lewis GB, Jr, Geller KA. Foreign bodies in the airway—a 5 year retrospective study with special reference to management. Ann Otol. 1980;89:437–442.
[28]. Liao R, Li JY, Liu GY. Comparison of sevoflurane volatile induction/ maintenance anaesthesia and propofol-remifentanil total intravenous anaesthesia for rigid bronchoscopy under spontaneous breathing for tracheal/bronchial foreign body removal in children. Eur J Anaesthesiol. 2010;27(11):930–4.
[29]. Sahin A, Meteroglu F, Eren S, Celik Y. Inhalation of foreign bodies in children: experience of 22 years. J Trauma Acute Care Surg. 2013;74(2):658–63.