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Safe and effective anaesthesia during paediatric rigid bronchoscopy: An experience at a tertiary care centre of Eastern India

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A B S T R A C T

Objective: Paediatric rigid bronchoscopy is always a challenging situation for anaesthesiologist and surgeon. Maintaining adequate ventilation and oxygenation is difficult as pulmonary gas exchange is reduced due to obstruction of airway by foreign body (FB). This study evaluates safe and effective anaesthesia during paediatric rigid bronchoscopy.

Study design: A retrospective study. Methods: We report a study of nine children who had undergone rigid bronchoscopy by use of spontaneous ventilation with fentanyl, propofol, dexamethasone, midazolam and sevoflurane without the use of muscle relaxant.

Results: Fentanyl, propofol, dexamethasone, midazolam and sevoflurane can be safely used in paediatric rigid bronchoscopy. No side effects are seen during and after the procedure. Conclusion: Spontaneous ventilation is usually the preferred method where propofol is combined with midazolam, fentanyl, dexamethasone and sevoflurane for safe and effective anaesthesia in children for rigid bronchoscopy.

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Introduction

Foreign body (FB) inhalation is a leading cause of death in children in the age of 1–3 years [1]. Most of the death occurs at the time of aspiration, but those who reach the hospital alive are very less in number. Early diagnosis and removal of airway FB protect the child from serious morbidity and mortality. Tracheobronchial FB should be removed as early as possible once it is confirmed. Paediatric patients always pose a challenging situation to the anaesthesiologist. Sometimes the scenario gets worse, when paediatric patients had been planned for rigid bronchoscopy to remove airway FB. A plain chest X-ray has a relatively low sensitivity and
specificity for tracheobronchial FB. The gold standard method for diagnosis and management for tracheobronchial FB is rigid bronchoscopy under general anaesthesia. Complete cooperation between endoscopist and the anaesthetist is paramount in getting an optimal outcome [2]. The anaesthetic goals at the time of rigid bronchoscopy include adequate depth of anaesthesia with minimal airway secretions, stable haemodynamics and rapid recovery of airway reflexes at the end of procedure. General anaesthesia can be either by spontaneous or controlled ventilation, which has its own merits and demerits.

Spontaneous ventilation is favoured by those who fear that positive pressure ventilation may dislodge the FB distally and thus making the retrieval of the object more difficult or making a ball valve obstruction with clinical deterioration [3]. Anaesthesia with spontaneous breathing through ventilating bronchoscope is usually preferred among patients with copious secretion and young paediatric patients. Spontaneous ventilation has more effective alveolar ventilation and allows better gas exchange in patients with inequalities in distribution of ventilation because of asymmetrical resistances among lung units [4]. Other major advantage of spontaneous ventilation is the absence of disruption of ventilation when attempting to retrieve the FB with the bronchoscope’s ocular piece open.

Propofol is associated with smooth induction, rapid recovery from anaesthesia and has synergistic hypnotic effects when used in conjunction with sedative/hypnotic agents like opioids, benzodiazepines [5]. As propofol is a poor analgesic, it requires an adjunctive analgesic agent like fentanyl. Sevoflurane is a sweet smelling non-inflammable highly fluorinated methyl isopropyl ether used for induction and maintenance of general anaesthesia. Midazolam is a water-soluble benzodiazepine GABA (gamma-aminobutyric acid A) receptor complex that is present in the spinal cord [6]. Our study aims to seek a safe and effective practice of anaesthesia and ventilation management in case of paediatric bronchoscopy in our tertiary centre.

Oxygen saturation in all other cases was also normal. Radiological examination was showing partial collapse of right lower lobe with compensatory emphysema in 5 cases where two children had collapse on right lower lobe with hyperinflation on the left side. Partial collapse of left lower lobe was seen in two children.

Anaesthetic consideration

All the patients were kept nil orally for 4 h prior to the procedure. The aim of the anaesthesia during rigid bronchoscopy for FB removal is always to maintain spontaneous respiration throughout the procedure. Premedication used was Injection Glycopyrrolate 10 μg/kg IV; Injection Midazolam 0.04 mg/kg IV Injection Fentanyl 1 μg/kg IV and preoxygenation for 3 min. Dexamethasone was given 0.1 mg/kg. The child was immobilized by hypnotic dose of propofol (2 mg/kg) with a maintenance infusion of 100–300 μg/kg to titrate depth of anaesthesia. The normal laryngoscopy was done and the trachea was sprayed via glottis with 1% lidocaine. All the patients were ventilated with a face mask and then handed over to the Otolaryngologist for rigid bronchoscopy. After induction of general anaesthesia, the rigid bronchoscope is inserted through the glottic inlet. The anaesthesia circuit was connected to the sideport of the bronchoscope for allowing ventilation. Sevoflurane was also used for maintenance through the side port of bronchoscope along with the 100% oxygen. In every case storz rigid bronchoscope with ventilating side arm was used for removal of foreign body. At the end of the procedure the child was administered 100% oxygen by anaesthetic mask and simultaneously nebulized with 1:10,000 adrenaline till completely awake.

Materials and methods

Study design

This is a retrospective study of nine children who underwent FB removal by rigid bronchoscopy under spontaneous ventilation using midazolam, fentanyl, propofol and sevoflurane without use of muscle relaxant. This study was done at our tertiary care centre during the last two years (January 2013 to March 2015)

Clinical recording of foreign body inhalation

History of FB inhalation (peanut – 4, whistle – 2, groundnut – 3) was elicited in all nine patients. The patients presented to Otorhinolaryngology Outpatient Department at an average 3 days after inhalation of foreign body (varied from 2 to 7 days). On clinical examination two children had features of respiratory distress with tachycardia and tachypnoea; however, their oxygen saturation on room was normal.

Results

Removal of airway FB by rigid bronchoscopy was successful in all 9 cases. Throughout the procedure, SpO2 ranged between 95% and 100% and no case converted into controlled ventilation. Pulse rate and mean arterial pressure remained within 10% of the baseline values during the procedure. Postoperative recovery was uneventful and X-ray chest done in all cases showed expansion of both lungs.

Discussion

Rigid bronchoscopy is performed in order to visualize the tracheobronchial airway and is carried out for either a therapeutic or diagnostic purpose. In 1897, Gustav Killian, a German Otolaryngologist performed the first bronchoscopy using a rigid esophagoscope and became successful in removing a pig bone from a farmer’s right main bronchus [7]. Rigid bronchoscopy is a brief and intensely stimulating procedure and presents a challenge to the anaesthetist and surgeon. As surgeon and anaesthesiologist share the management of the obstructed airway with FB, there should be a clear communication and very good cooperation is essential. Before the procedure, a detailed anaesthetic and operative
plan should be discussed. The important anaesthetic issues like methods of induction, ventilation during bronchoscopy and maintenance of anaesthesia should be well planned and discussed. The small airway of the paediatric patient is shared for both anaesthesia and bronchoscopy and needs good cooperation and communication between endoscopist and anaesthesiologist for getting an optimal outcome. The aims of the anaesthetic intervention are adequate oxygenation and ventilation, adequate depth of anaesthesia with minimal airway secretions, controlled cardiorespiratory reflexes and stable haemodynamics during rigid bronchoscopy, rapid return of upper airway reflexes and prevention of pulmonary aspiration [8].

Spontaneous ventilation and controlled ventilation are both feasible for removal of tracheobronchial FB. Spontaneous ventilation around the rigid bronchoscope may be more suitable for removal of proximal FB, during which leakage around the scope may make the effective positive pressure ventilation difficult. Closing the mouth and nose manually can decrease a large leak around the scope and improve the ventilation. So the advantages of spontaneous ventilation are to provide continuous ventilation despite interruptions in the anaesthesia breathing circuit and in the case of obstructive lesions negative pressure breathing may give better oxygenation and ventilation [9]. Positive pressure ventilation with intermittent apnea while manipulating FB may be more suitable for distal retrieval. The use of optical forceps allows for positive pressure ventilation to be maintained while the FB is being manipulated so that period of apnea can be minimized.

Laryngeal oedema, haemorrhage and tracheobronchial lacerations can occur during rigid bronchoscopy [10]. Tension pneumothorax is the most serious complication during the rigid bronchoscopy because of instrumentation leading to a rent allowing the air to enter the pleural cavity during positive pressure ventilation and not allowing it to leave during expiratory phase [11].

Litman et al. [12] in a retrospective study of tracheobronchial FB removal under general anaesthesia compared 47 children managed with controlled ventilation by use of a muscle relaxant and 26 children by spontaneous ventilation using halothane/sevoflurane and they found that 11 patients needed change from spontaneous to controlled ventilation. In one case, it was due to laryngospasm whereas in others it was because spontaneous ventilation was not sufficient to maintain normoxemia or normocarbia was needed as the patient was moving. In our study no patient required change from spontaneous to controlled ventilation. Here, propofol was used for induction and sevoflurane along with propofol was used for maintaining anaesthesia adequately. Sevoflurane has become the drug of choice for inhalation induction. A study by Meretoja et al. found that sevoflurane was associated with lesser number of side effects compared to halothane during bronchoscopy and gastroscopy in children [13].

Shigheki et al. [14] had done a comparative study of intravenous anaesthesia with propofol, fentanyl and thiopental-sevoflurane anaesthesia using laryngeal mask airway for diagnostic bronchoscopy among 60 patients and found to have superior maintenance of cardiovascular stability. The major advantage of propofol is that it is noncumulative when used for a short period of time and avoids the need of the bronchoscopist to inhale anaesthetic vapours when the ventilating system opens during FB retrieval [12]. Propofol provides rapid recovery with good reflex suppression and fentanyl provides a high degree of airway reflex suppression but to be used carefully in paediatric patients once the airway is secured [2].

In prospective clinical study [15] comparing spontaneous and controlled ventilation during paediatric rigid bronchoscopy for FB removal comparing two groups one with suxamethonium and one with halothane. All the patients in this study with spontaneous ventilation were converted to assisted ventilation due to desaturation or inadequate depth of anaesthesia. Higher incidence of coughing and buckling were found in spontaneous ventilation. However, there was no movement experienced in any of the cases due to use of propofol and sevoflurane for maintenance of adequate depth of anaesthesia.

The controlled positive pressure ventilation by use of a neuromuscular blockade may cause unintentional movement of foreign body to the distal part of the airway [16], which can be avoided by using the technique of spontaneous ventilation as in our study.

Conclusion

FB bronchus is a life-threatening event in a child and needs early intervention. Early diagnosis, prompt treatment, vigilant monitoring and very good cooperation between anaesthetist and surgeon are of paramount importance in managing the rigid bronchoscopy in paediatric patients. It is recommended that these patients are cared by the most skilled team available with safe and effective general anaesthesia. Spontaneous ventilation is usually the preferred method where propofol is combined with midazolam, fentanyl, dexamethasone and sevoflurane for safe and effective anaesthesia in children for rigid bronchoscopy.

Study limitation

This study has a relatively small sample size and may limit the outcome of the above interpretation. However, the outcome of this study will definitely encourage the use of propofol, fentanyl, midazolam, dexamethasone and sevoflurane for children undergoing rigid bronchoscopy for FB removal from bronchus.

Authors’ contributions/Wkład autorów

According to order.

Conflict of interest/Konflikt interesu

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None declared.

Ethics/Etyka

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; EU Directive 2010/63/EU for animal experiments; Uniform Requirements for manuscripts submitted to Biomedical journals.

REFERENCES/PISMENICTWO