Risk factors of hypoxia during flexible bronchoscopy use in infants

A Japanese, Shigeto Ikeda, invented the flexible bronchoscope (FB) in 1966; the FB was introduced into clinical practice due to its diagnostic accuracy, safety, and ease of use. Currently, the FB is one of the most important tools for diagnosis and treatment of pulmonary diseases in child and infants. The tendency to subdivide bronchoscopes into adult and pediatric categories depending on their outer diameters is arbitrary. The more interventional procedures via FB that are performed in the pediatric population depend on experience and the situational need. The procedures can be easily performed both in an outpatient setting and in patient service under moderate sedation and local anesthesia. The dynamic airway obstruction often is better assessed with a FB than a rigid bronchoscope. The indications for fiberoptic bronchoscopy are broad and growing, including laryngomalacia, bronchomalacia, tracheomalacia, and suspected airway problems (persistent stridor, foreign body aspiration, hoarseness, unexplained inspiratory retraction, or unresolved pneumonia, etc.). Therapeutic bronchoscopy with the standard flexible bronchoscope has long been used for the removal of foreign bodies and stent placement; bronchoscopy can also be used for the relief of large airway obstruction.

FB is usually performed via the oral or the nasal route. The need for sedation is to improve patient comfort and add to the ease of the procedure for the bronchoscopist. Some studies reported that 16% to 21% of physicians use general anesthesia for FB. Intravenous preparations of various sedatives such as diazepam, midazolam, lorazepam, morphine sulfate, fentanyl, and hydrocodone have been used either singly or in combination based on bronchoscopist preference and the availability of the drug. There are multiple techniques for flexible fiberoptic bronchoscopy. Options include awake versus general anesthesia and oral versus nasal approaches. Options for local anesthesia include topical anesthesia via a nebulizer, handheld aerosol, or nerve blocks (laryngeal and/or glossopharyngeal nerves) and direct administration of local anesthetic through the bronroscope. Options during general anesthesia include spontaneous versus positive-pressure ventilation with or without muscle relaxation. Inhalation, intravenous anesthetics, or both can be used for anesthesia. Patients who have copious secretions in the preoperative period should receive anticholinergic medication to ensure a dry field, which provides optimal visualization with the FB. Lidocaine is the most commonly used drug for local anesthetic agents.

Soong and colleagues clearly demonstrate in this issue that intravenous sedation with midazolam, ketamine, atropine, and topical anesthesia of lidocaine offer a relatively wide margin of safety with a rapid onset and sufficient duration of action to allow the completion of most bronchoscopic procedures.

All FB procedures are performed observing universal precautions. Following each procedure, the instrument is thoroughly disinfected or sterilized according to the published consensus statement. To ensure adequate oxygenation (oxygen saturation >92%) and hemodynamic stability, pulse oximetry, heart rate and blood pressure are monitored throughout the procedure, the risks associated with interventional procedures can be significant. The majority of our currently performed interventional procedures all strive to maintain airway patency and reestablish normal gas exchange or to reestablish the airway structure to as near normal as possible. Pulse oximetry is a painless, cost-effective, and more sensitive test rather than arterial blood gas analysis for hypoxia evaluation. The British Thoracic Society recommends that all patients undergoing FB should have pulse oximetry measured and supplemental oxygen should be given to maintain the arterial oxyhemoglobin saturation at or above 90%. However, there is little mentioned in the literature about what method or methods of supplemental oxygen could feasibly and efficiently achieve the ≥90% arterial oxyhemoglobin saturation, especially in the infant age.

Supplemental oxygen is routinely administered during FB to minimize the risk of dangerous hypoxia. Nasal cannula offers the simplest means of administering oxygen during transnasal FB; as transnasal FB became popular, supplemental oxygen was delivered by nasal cannula, which is placed either in the nares or in the mouth. Schnapf reported 36 children in the youngest age group, 6 to 12 months, who showed the greatest drop in saturation when compared with the other groups. A decline in arterial oxygen saturation was frequently noted during FB in infants and children; the risk of desaturation is increased when the bronchoscope was positioned in the mid-trachea. Harless and colleagues reported the efficacy of nasal prongs placed in the mouth of 16 patients undergoing transnasal FB. Weber and others conclude that nasal prongs are as effective as an nasopharyngeal catheter in delivering oxygen to children with a hypoxemia, and they are also safer to use. Cost permitting, they are a more appropriate means of oxygen delivery to children with hypoxemia and acute lower
respiratory tract infection in hospitals in developing countries. Milman and colleagues\textsuperscript{15} reported the delivery of oxygen via a pharyngeal catheter produced fewer episodes of hypoxemia than nasal cannula or no oxygen supplementation.

There is a risk of hypoxia during FB, which may occur through the combination of several mechanisms including underlying disease, oversedation, airway suction removing oxygen or decreasing lung volume, and increased ventilation-perfusion mismatching by concomitant airway block and spasm, bleeding, and instillation of fluids. Because oversedation can depress respiration and lead to hypoxemia, FB-associated hypoxemia may persist for several hours after the procedure; this necessitates the close monitoring of patients during the recovery period. Significant hypoxemia can usually be prevented by the administration of supplemental oxygen during the procedure and recovery.\textsuperscript{11–15}

The article by Soong and colleagues\textsuperscript{9} in this issue describes 75 infants in three groups of 25 infants; the infants were randomly applied with three different oxygen delivery techniques (nasal cannula, nasal prongs, and nasopharyngeal catheter) during and 30 minutes after the FB procedure. The article illustrates that supplemental oxygen via nasopharyngeal catheter is a a simple and cost-effective method to maintain good oxyhemoglobin saturation during FB examination in infants.\textsuperscript{9}

In conclusion, a decline of oxyhemoglobin saturation is frequently noted during FB examination in infants. The risk of desaturation is increased when the FB is located in the central airway of pharynx and carina, and it can be successfully managed by using supplemental oxygen. Nasopharyngeal catheter could be a simple and cost-effective method for supplementing of oxygen.

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