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SCIENTIFIC ARTICLE

Difficult Airway Intubation with Flexible Bronchoscope

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Abstract
Background and objective: To describe the efficacy and safety of a flexible bronchoscopy intubation (FBI) protocol in patients with difficult airway.
Method: We reviewed the medical records of patients diagnosed with difficult airway who underwent flexible bronchoscopy intubation under spontaneous ventilation and sedation with midazolam and fentanyl from March 2009 to December 2010.
Results: The study enrolled 102 patients, 69 (67.7%) men and 33 (32.3%) women, with a mean age of 44 years. FBI was performed in 59 patients (57.8%) with expected difficult airway in the operating room, in 39 patients (38.2%) in the Intensive Care Unit (ICU), and in 4 patients (3.9%) in the emergency room. Cough, decrease in transient oxygen saturation, and difficult progression of the cannula through the larynx were the main complications, but these factors did not prevent intubation.
Conclusion: FBI according to the conscious sedation protocol with midazolam and fentanyl is effective and safe in the management of patients with difficult airway.

Introduction

Difficult airway management is always a relevant topic. Hypoxia due to ventilation failure is a major cause of death and serious neurological sequelae in patients with difficult airway.

Flexible bronchoscopy intubation (FBI) is safe, effective, and considered the method of choice for managing expected and unexpected difficult airway, as long as it is not an emergency situation (i.e., a situation known as “can’t intubate, can’t ventilate”).

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Murphy[1], in 1967, performed the first FBI in a patient with severe rheumatoid arthritis. Stiles et al.[2], in 1972, published the first series of intubations with flexible bronchoscope.

Table 1 **Mallampati Classification**

Class I	Full visibility of tonsils, uvula, and soft palate
Class II	Visibility of soft palate, upper portion of tonsils, and uvula
Class III	Hard palate and base of the uvula are visible
Class IV	Only hard palate is visible

Table 2

Sex	
Male	69 (67.7%)
Female	33 (32.3%)
Indications	
Mouth opening limitation	21 (20.5%)
Obesity	19 (18.6%)
Cervical trauma	25 (24.5%)
Cervical ankylosis	10 (9.8%)
Ankylosing spondylitis	06 (5.8%)
Tracheal compression by mediastinal mass	06 (5.8%)
Mandible fracture	04 (3.9%)
Facial trauma	03 (2.9%)
Trismus	03 (2.9%)
Cervical hemangioma	04 (3.9%)

Methods

We reviewed the medical records of patients with difficult airways requiring FBI from March 2009 to December 2010.

The anesthesiologist and the emergency room or ICU physician made the diagnosis of difficult airway during evaluation based on the American Society of Anesthesiologists guidelines, as described in the medical record.

Data collected during the medical records review were sex, age, FBI tube size, causes of difficult airway, and success and complications of the procedure.

The respiratory endoscopy team had experience with difficult airways and followed the same protocol for FBI. During the procedure, the bronchoscopist stood behind the head of the patient, who was in the supine position. Bite block was used in all patients. Supplemental oxygen (2-3 $L.min^{-1}$) was supplied through a nasopharyngeal catheter during the procedure to increase the fraction of inspired oxygen and maintain a SpO_2 of at least 90%. Conscious sedation was achieved with an intravenous combination of midazolam (0.03 to 0.05 $mg.kg^{-1}$) and fentanyl (0.5-1.5 $mcg.kg^{-1}$).

The team previously removed the connector tube to allow the removal of the bite block removal after the procedure. Endotracheal tube (ETT) and bronchoscope were lubricated with 2% lidocaine gel. ETT was then slipped over the bronchoscope and cuff fully deflated.

Bronchoscope was inserted through the bite block, and oropharynx and larynx topical anesthesia performed with 1% lidocaine solution instillation, without vasoconstrictor, through the suction channel of the bronchoscope, at a maximum dose of 5 $mg.kg^{-1}$ (Figure 1). This technique allows a direct visualization of the structures to be anesthetized; however, often causes reflex cough in the first minutes. Thus, lidocaine was sprayed on vocal folds, subglottis, and proximal trachea. Two minutes were expected before introducing the bronchoscope and ETT into the lower airway, which reduced the laryngospasm and unrestrained cough.

With bronchoscope into the trachea, the tube was advanced to the distal trachea and subsequently pulled to a distance of 3 cm from the carina to prevent main bronchi accidental selective intubation (Figure 3). Finally, the cuff was inflated, and fast onset medications administered intravenously.

Results

Of the 102 patients selected, 69 (67.7%) were male and 33 (32.3%) female. The mean age of patients was 44 years. In 59 patients (57.8%) with expected difficult airway, FBI was performed in the operating room. Thirty-nine intubations (38.2%) occurred in the Intensive Care Unit (ICU), and included expected and unexpected difficult airway. Another 4 cases (3.9%) occurred in the emergency room. There were no serious complications, and all intubations were successful.

FBI indications included mouth opening limitation (n = 21), obesity (n = 19), cervical spine injury (n = 25), cervical ankylosis (n = 10), ankylosing spondylitis (n = 6), airway compression due to cervical and mediastinal masses (n = 6), mandibular fracture (n = 5), cervical hemangioma (n = 4), facial trauma (n = 3) and trismus (n = 3).

All procedures were successfully performed using the flexible bronchoscope with an external diameter of 4.9 mm. (FB 15X, Pentax, Tokio, Japan).

Six patients were excluded from the original sample of 108 subjects: three for intubation with double lumen cannula, in which bronchoscopy was used only to check the positioning, and three for laryngotracheal stenosis requiring rigid bronchoscopy dilatation.

Cough was the main complication of FBI, affecting all patients in the first minutes during topical lidocaine instillation. Fifteen patients had a transient decrease in SpO_2 below 90%, particularly in the emergency room and ICU, which was reversed after mechanical ventilation without compromising the intubation success. In 10 patients, the progress of tracheal tube towards the trachea was not successful on first attempt, requiring a tube rotation maneuver to pass through the larynx and finish intubation.

Discussion

FBI is a safe and effective technique for solving cases of difficult airway. It can be performed with the patient in various positions; however, for the bronchoscopist, the most convenient position is standing behind the patient's head with the patient in the supine position. It is recommended to keep the bronchoscope and its light source on the left side of the patient to facilitate the equipment management, as all cables are inserted through the left side. The relationship between a good patient positioning and the easiness of flexible bronchoscopy has clinical relevance[6].

Clinical evaluation is able to predict a case of difficult airway. The failure of this evaluation, curarization, and difficult intubation may result in the "can't intubate, can't ventilate" emergency where, in the absence of training, inadvertent maneuvers and improvisations arise, which may potentiate errors. FBI is not indicated for patients who are in the "can't intubate, can't ventilate" situation.

Indications for FBI include: history of difficult intubation, evidence of a possible difficult intubation, such as limited mouth opening, short thyromental distance, macroglossia, obesity, and sleep apnea; airway compromised by infection, tumor, edema, and bruising; inability to extend the neck or cervical instability; fragile or protruding teeth; patients with Mallampati class III-IV [4].

Mallampati classification is used to predict easy intubation, performed with the patient in the sitting position, head in neutral position, mouth wide open, and tongue fully extended. Based on the visibility of the base of uvula, tonsils, faucial pillars, and soft palate, it is divided into four classes: Class I: full visibility of tonsils, uvula, and soft palate. Class II: visibility of hard and soft palate, upper portion of tonsils, and uvula. Class III: soft and hard palate and base of the uvula are visible. Class IV: only hard palate is visible. Class I or II results suggest easy intubation with conventional laryngoscope. Classes III or IV suggest difficult laryngoscopy. Mallampati classification should not be used alone as a predictor of difficult airway and depends on patient's cooperation [4].

Neck extension is not indicated in patients with unstable cervical spine caused by fractures; thus, airway management in these patients is a challenge. In these cases, intubation with direct laryngoscopy is feasible and widely used in emergency rooms. To reduce cervical spine movement as a result of direct laryngoscopy, neck stabilization is applied, minimizing the degree of cervical spine extension [7-10]. However, FBI should be considered in these patients, especially in elective situations.

Some contraindications for FBI are stenosis and compression of airways not traversable by the bronchoscope, upper airway severe bleeding, and lack of training in the use of flexible bronchoscope [4].

After induction of general anesthesia with neuromuscular blockers, FBI should be avoided in patients with expected difficult airway. Intubation under spontaneous ventilation with sedation or topical anesthetic alone is safer. Occasionally, when trying to advance the tracheal tube over the flexible bronchoscope, resistance may occur at the glottis level, which delays or even prevents intubation [11]. In our series, there was no ETT progression in 10% of intubations on first attempt, and tube rotation maneuvers were required to complete the procedure.

All patients in our study underwent intubation under spontaneous ventilation, sedation with midazolam (0.03-0.05 $mg.kg^{-1}$), combined with intravenous fentanyl (0.5-1.5 $mg.kg^{-1}$) and topical anesthesia with lidocaine. The ideal sedation allows the patient to maintain spontaneous ventilation and protect his own airway, be cooperative and tolerate the bronchoscope passage. Agents used to induce sedation generally fall into two groups: opioids and benzodiazepines. The combination of midazolam and fentanyl is very effective in achieving reflex suppression, sedation, and analgesia. The use of remifentanil, ketamine, propofol, and dexmedetomidine is reported in FBI with good results [7,12-14]. Regardless of the chosen agent, the most important factor is to maintain the patient's spontaneous breathing.

The presence of secretions in the oral cavity may hinder bronchoscopy. Gentle oral cavity aspiration is effective in most cases. Although the routine use of antisialogogues is not recommended, some patients may require the administration of medications to reduce secretion and allow better visualization of structures. Atropine is widely used when there is no contraindication.

Laryngotracheal structures topical anesthesia with 1% lidocaine is effective to eliminate airway reflexes, such as coughing and laryngeal spasm, and essential to the success of FBI (Image 1). Lidocaine provides excellent topical anesthesia, with little risk of systemic toxicity up to a total dose of 3-4 $mg.kg^{-1}$. Transtracheal injection of lidocaine and regional blockade of the airway sensory nerves are also effective, but seem to offer little advantage over simple topical anesthesia. Moreover, these procedures are technically more difficult to perform and have a higher risk of complications, including bleeding, nerve damage, and intravascular injection [5,7]. All of our patients had transient cough, especially during the instillation of topical lidocaine, but this did not prevent intubation. No patient had laryngospasm. There was a decrease in SpO_2 below 90% in 15 patients during intubation despite supplemental oxygen, especially in the ICU and emergency rooms, which was reversed after intubation. We believe that this SpO_2 oscillation was due to patients' condition severity.

Difficulties may arise at many levels during difficult airway management with flexible bronchoscope. FBI provides a direct view of the larynx, but intubation is "blind". Since the diameter of the ETT is greater than the bronchoscope, ETT bevel may anchor in the arytenoid cartilages (Figure 4). The smaller the gap between the bronchoscope shaft and the tube wall, the less likely the tube will be to get caught on the arytenoids. Ideally, this gap would be no greater than 1.5 mm (Figure 5) [15]. Any resistance to the endotracheal tube advancement should be overcome by rotating the tracheal tube around the bronchoscope shaft.

When performing an elective FBI, the use of a standard tracheal tube is recommended, as it has the same success rate and costs significantly less than a wire-reinforced endotracheal tube [11].

In special situations and emergencies, FBI may be performed through the laryngeal mask airway, which allows patient ventilation during the procedure [16-18]. Disadvantages of the technique are the high costs of instruments and equipment fragility.

Some limitations of this retrospective study are the lack of data regarding the time required for intubation, number of attempts with conventional laryngoscope, and comparison between FBI and other intubation devices for difficult airway that could be as effective as the bronchoscope. Numerous video laryngoscopes and optical devices have been developed as potential options to conventional direct laryngoscopy. Compared with flexible bronchoscope, these devices are cheaper and may be simpler to use [4,15,19].

The difficult airway algorithm of the American Society of Anesthesiologists suggests that intubation should be made with the patient under spontaneous ventilation in cases of suspected difficult airway [20], with FBI as the gold standard for difficult airway management. Nevertheless, only 59% of anesthesiologists in the United States reported having expertise in FBI [21]. The prevalence of physicians with expertise in FBI is still low. The fact that patients with difficult airway are relatively rare may be the reason for doctors' lack of interest in specific training for this procedure.

In conclusion, FBI for difficult airways management performed with the patient under spontaneous ventilation, sedated with intravenous midazolam and fentanyl and topical anesthesia with lidocaine is effective and safe.

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