Anesthesia for bronchoscopy and interventional pulmonology: from moderate sedation to jet ventilation

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Purpose of review

The field of interventional bronchoscopy has seen an evolving need for different types of anesthesia for various procedures. This review describes recent advances in the field of anesthesiology that have increased the suitability of conscious sedation under monitored anesthesia care or general anesthesia for prolonged and complex interventional bronchoscopic procedures, especially those performed on severely ill patients. Additionally, the pros and cons of performing bronchoscopic procedures in the bronchoscopy suite versus the operating room are analyzed.

Recent findings

Although conscious sedation is the most commonly used form of anesthesia for simple bronchoscopic procedures, general anesthesia is emerging as a more appropriate technique for newer, more complex interventional bronchoscopic procedures. Large interventional pulmonology departments have state-of-the-art bronchoscopy suites in which both conscious sedation and general anesthesia are used. New advances in the field of anesthesiology such as the laryngeal mask airway, short-acting anesthetics with minimal effect on respiratory function, and mechanical jet ventilators are well suited for interventional bronchoscopic procedures.

Summary

Interventional bronchoscopists are encouraged to examine the pros and cons of different types of anesthesia for various bronchoscopic procedures.

Keywords

anesthesia, interventional bronchoscopy, laryngeal mask airway, mechanical jet ventilation

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Introduction

The field of interventional bronchoscopy is rapidly expanding as new techniques and equipments are invented. Simple airway procedures of short duration can be easily performed under local anesthesia and/or moderate sedation. More complex procedures of long duration and more risk to the patient are best performed under general anesthesia with special modes of ventilation and monitoring. This review will discuss the need for different types of anesthesia, where to perform the procedures, choice of anesthesia, and new advances in anesthesia that complement advances in interventional bronchoscopy.

Need for anesthesia

Thousands of bronchoscopic procedures are performed every day [1]; for each procedure, the question of whether to use anesthesia must be addressed. An interventionalist may consider anesthesia at the patient's request or because a procedure requires the patient to remain still for a prolonged duration. Since the beginning of the 20th century, local anesthetics were used for diagnostic bronchoscopic procedures to reduce airway discomfort. It was soon discovered that the effectiveness of local anesthetic is limited by its inability to reduce the patient's anxiety [2,3]. In addition, local anesthetics have a maximum dose that limits their repeated use in prolonged procedures [4].

As a result, conscious sedation with antianxiety and/or pain-reducing medications, alone or in combination with local anesthesia, has become the preferred form of anesthesia for diagnostic bronchoscopic procedures [5••]. However, conscious sedation also has limitations. The drug doses required to achieve the desired effect vary widely among patients. Slow titration can be time-consuming, and it does not guarantee that undesired side effects will not occur. Complications related to conscious sedation vary and include amnesia for prolonged periods following the procedure, hypoventilation, hypoxemia, loss of airway patency, and hemodynamic instability [6,7]. Unfortunately, it becomes the responsibility of

the interventionalist to manage these complications, diverting his or her attention from the procedure. In some reported instances, bronchoscopic procedures have been terminated early because of complications from conscious sedation [7]. Complications related to conscious sedation may also occur in the recovery area, delaying patient discharge and occasionally requiring unplanned hospital admission [8•].

As the field of interventional bronchoscopy emerges, a growing number of lengthy and technically demanding procedures are being performed every day. Furthermore, interventional bronchoscopic procedures are often performed in patients with comorbidities that necessitate vigilant monitoring and management of hemodynamic and airway problems. Interventional bronchoscopists are coming to the realization that local anesthesia and conscious sedation are not ideally suited for providing prolonged anesthesia for such patients. As a result, some centers in the US and Europe have made it their standard practice to have an anesthesiologist provide either sedation or general anesthesia to selected patients undergoing interventional bronchoscopy. This arrangement allows the interventionalist to direct his or her full attention to the bronchoscopic procedure, the patient to go through the procedure with minimal or no discomfort, and the anesthesiologist to manage the patient's medical condition and sedation vigilantly.

Interventional pulmonary suites

Although anesthesiology support for interventional bronchoscopic procedures might be ideal, it is not feasible for most centers due to the following issues. Most anesthesiology departments will agree to perform anesthesia for airway procedures only in the operating room where sophisticated equipment to manage airway problems is within immediate reach and surgical support is available should complications occur [9]. Meanwhile, interventional pulmonologists do not normally have assigned blocks of operating room time and find it difficult to reserve an operating room on short notice. Another issue is the transportation and storage of large, sophisticated, and delicate interventional bronchoscopic equipment. Occasionally, such equipment is stored in the operating suite, which is considered a valuable and expensive real estate. More often the equipment is transported to the operating room on a case-by-case basis, which is a labor-intensive and time-consuming process that may result in equipment damage.

To bypass all these hurdles, some large interventional pulmonology departments with high case volumes have designed fully equipped interventional pulmonary suites located outside the operating room [10]. Anesthesiologists are usually involved in the design of these suites in which up-to-date anesthesia equipment, oxygen, air, and suction ports as well as a scavenging system for volatile anesthesics are incorporated into the suite design. Protocols for the management of emergency situations, such as the need for blood transfusion or surgical support, are also in place. In other words, interventional pulmonary suites are designed as operating room replicas [11].

Key points

- General anesthesia is emerging as a more appropriate technique for newer, more complex interventional bronchoscopic procedures.
- There are new state-of-the-art bronchoscopy suites in which both conscious sedation and general anesthesia are used.
- New advances in the field of anesthesiology are well suited for interventional bronchoscopic procedures.

Interventional pulmonary suites in several centers in the US and Europe have been operational for several years with great success [12••]. For example, the interventional pulmonary suite at The University of Texas MD Anderson Cancer Center has been operational for 7 years, and the center's interventional pulmonologists perform an estimated 700 procedures with anesthesiology support every year. These procedures include endobronchial ultrasound-guided transbronchial needle aspiration 'EBUS-TBNA', rigid bronchoscopies, and pleuroscopies.

Choice of anesthesia

The American College of Chest Physicians in 2003 left the choice of anesthesia to the interventionalist and indicated in its guideline that 'all procedures may be performed using local anesthesia with or without conscious sedation or using general anesthesia as indicated by the applicable guidelines in a particular practice environment (p. 1694). 'However, general anesthesia was recommended for rigid bronchoscopy and for pediatric bronchoscopic procedures' [1].

A more defined guideline from the European Respiratory Society and the American Thoracic Society on interventional pulmonolgy in 2002 (ERS/ATS) stated that 'Although several procedures can be performed by flexible bronchoscopy with local anesthesia and conscious sedation, the interventional bronchoscopist should be prepared to convert to general anesthesia, if the situation requires (p. 358)'. The ERS/ATS also recommended that the design of the bronchoscopy suite should account for the presence of anesthesia equipment [11].

Although performing interventional bronchoscopic procedures using local anesthesia with or without conscious

sedation appears to be a common practice, it is important to recognize the various indicators of the need for anesthesiology support during a bronchoscopic procedure.

Patient-related factors

Patients with increased American Society of Anesthesiologists (ASA) score, acute illness, and poor baseline oxygen saturation benefit from anesthesia support. These patients are less able to tolerate the transient hypoxia associated with bronchoscopy and often require high-flow oxygen therapy or positive pressure ventilation as well as invasive monitoring [13]. The presence of an anesthesiologist becomes invaluable in these circumstances. The anesthetics of choice in these patients are the modern ultra-short-acting drugs allowing rapid recovery and return to baseline function without the need for prolonged postprocedure mechanical ventilation [14].

Airway disease-related factors

Central airway obstruction and severe hemoptysis carry the risk of respiratory failure with acute loss of airway patency during a bronchoscopic procedure. The presence of an anesthesiologist during the procedure allows for the emergent management and re-establishment of a patent airway via intubation [13].

Procedure-related factors

The procedure being performed often guides the choice of anesthesia.

Rigid bronchoscopy performed using local anesthesia was first described in 1947. Since then, reports of rigid bronchoscopy performed using conscious sedation and spontaneous ventilation have been published [15]. Currently, general anesthesia with adequate muscle relaxation prior to the insertion of the rigid bronchoscope is regarded by many authorities as essential for avoiding airway injury [1]. Hypoxemia and hypercapnia commonly occur during rigid bronchoscopic procedures mandating the use of spontaneous assisted, or jet ventilation [16,17].

EBUS-TBNA is a relatively well tolerated procedure and is commonly performed using local anesthesia with conscious sedation. However, general anesthesia is often used when EBUS is performed with the intention to stage lung cancer. Mediastinal staging can be quite lengthy as small lymph nodes and multiple lymph node stations are sampled [18]. Rapid on-site specimen evaluation also adds time to the procedure, further buttressing the case for longer sedation [19]. We have recently described a well tolerated general anesthesia technique for the EBUS procedure [20].

Advances in anesthesia

There is a common false perception among interventionalist that anesthesia comes with an additional risk to the procedure. The ASA has been taking several steps to make anesthesia safer now than ever. Currently anesthesia is regarded as a leader in patient safety and serves as a model for improving patient safety in healthcare. Following are several advances in anesthesiology that render anesthesia exceptionally safe and well suited for interventional bronchoscopic procedures.

Monitoring the depth of anesthesia

Electroencephalograms can be used to monitor the depth of anesthesia, and the data in combination with the patient's clinical signs can guide titration of the dose of intravenous anesthetics [8•]. As a result, adequate sedation without undesired side effects such as respiratory failure or cardiovascular instability is more likely to be achieved [21].

Modern intravenous anesthetics

Modern anesthesia medications are better suited for bronchoscopic procedures due to the rapid elimination and ultrashort duration of action or the ability to induce anesthesia or sedation without affecting the respiratory drive.

Propofol, similar to benzodiazepines, acts to facilitate the inhibitory effect of γ-aminobutyric acid. When used for sedation for airway procedures, propofol has been shown to be superior to midazolam due to its short onset time of 30 s, metabolism independent of organ function and rapid recovery time of 15 min after 2 h infusion. Additionally propofol has been shown to have a significantly better neuropsychometric recovery in contrast to midazolam [8•]. When compared to inhalation anesthetics, propofol have been shown to reduce coughing and the depression in ciliary function [22] as well as the release of cytokines and the stress hormone response [23,24].

Remifentanil is the shortest acting narcotic available with duration of action of 3–10 min and rapid onset of action (1 min). After interventional bronchoscopic procedures patients do not suffer from postprocedure pain thus eliminating the need for the use of long-acting narcotics. Remifentanil is ideal for blunting airway reflexes during the procedure with no residual effect in the recovery room [14].

Ketamine induces a dissociative state in which sensory stimuli are blocked from reaching the cerebral cortex with associated amnesia and analgesia. Although it is an old drug, its use has been revived because its profound analgesic property makes it a good adjunct to propofol [25]. Ketamine is particularly valuable for bronchoscopic procedures because of its bronchodilating properties and because it does not induce respiratory depression.

Dexmedetomidine is an α-2 agonist that inhibits norepinephrine release. Dexmedetomidine has a unique

ability to provide sedation and analgesia without causing respiratory depression [26]. Dexmedetomidine has also been found to offer cardioprotective benefits during surgery by lowering perioperative oxygen consumption, and the stress response. [27].

Laryngeal mask airway

The laryngeal mask airway (LMA) has been in use for nearly 20 years with consistently minimal complications [28]. Interventional bronchoscopists can benefit from the LMA because it is placed above the level of the vocal cords, allowing inspection of the entire airway [29]. The LMA is preferable to endotracheal intubation in patients with tracheal stenosis or tumors, in whom an endotracheal tube could be traumatic and difficult to place [30]. Additionally, the lumen of the LMA is large enough to introduce the large therapeutic bronchoscope without obliterating the ventilating lumen [20].

Mechanical jet ventilation

Mechanical jet ventilators are now available in the US and in Europe. These devices allow users to control the frequency of respiration, inspiratory time, driving pressure, and fraction of inspired oxygen. Additionally, mechanical jet ventilators can humidify the inspired oxygen up to 100% allowing prolonged periods of jet ventilation without the risks of airway mucosa dryness and necrosis or damage to ciliary function [31]. In contrast to the manual jet ventilator, mechanical jet ventilators are equipped with two alarm systems to protect against barotrauma.

Conclusion

The field of interventional bronchoscopy has been evolving and becoming more sophisticated, as has the field of anesthesiology. As a result, the older techniques of local anesthesia may not be as well suited for new, complex, prolonged bronchoscopic procedures. Communication between interventional bronchoscopy departments and anesthesiology departments is necessary to delineate when anesthesia services are needed and where certain bronchoscopic procedures should be performed. Recent advances in the field of anesthesiology render both conscious sedation under monitored anesthesia care and/or general anesthesia for interventional bronchoscopy safe, and the use of these advances is invaluable for the continued growth of the field of interventional bronchoscopy.

References and recommended reading

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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 294).

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