Anesthesia for pulmonary stent insertion

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Purpose of review
To familiarize anesthesiologists with recent advances in endoscopic pulmonary stenting. These interventions have replaced surgical procedures for the relief of central airway obstructions.
Recent findings
A pulmonary stent can provide immediate relief of symptoms and improvement in pulmonary function for both intrinsic and extrinsic airway lesions. The current indications for the use of both silicone-rubber stents and expandable metal stents are reviewed. Considerations for the anesthetic management of patients undergoing pulmonary stent placement are also discussed.
Summary
Tracheo-bronchial stenting procedures are being employed with increasing frequency. The practicing anesthesiologist must be familiar with the management of patients undergoing airway stenting procedures.

Keywords
stenosis, malignant, benign, metal stent, silicone stent, bronchoscopy, jet ventilation

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Abbreviation

ETT endotracheal tube

0952-7907

Introduction

The stenting of stenotic blood vessels, airways and ducts has revolutionized the management of these problems. The stenting of central airways is an effective means of providing structural support to the trachea, carina and main bronchi. In most instances an obstruction can be relieved without painful surgery and with immediate symptomatic improvement. Since these procedures are now becoming routine, every anesthesiologist must be familiar with the management of the patient undergoing pulmonary stent insertion.

Review

Symptomatic obstruction of the central airways can be due to a great variety of benign and malignant processes. The numerous interventions used to relieve central airway obstruction include surgical resection or core-out, Nd-YAG laser ablation, photodynamic therapy, brachytherapy, cryotherapy, electrocautery, and pulmonary stenting [1,2••]. While all of the above are useful for intrinsic obstructions, only pulmonary stenting can provide effective structural support for patients with malacia and extrinsic airway compression, as well as those with intra-luminal obstructions [3•].

Airway stents

Airway stenting is frequently used following lung transplantation complicated with graft rejection or infection [4,5•], after tracheo-bronchial injury [6], for congenital tracheal stenosis [7•], for stenosis due to infection or inflammation, as well as for the many unique and rare causes of airway obstruction [8,9]. Certainly the greatest clinical application for pulmonary stents continues to be for obstructions due to intrinsic and extrinsic tumors of the airways [10•].

Successful stenting with a silicone or metal stent can provide symptomatic relief of life-threatening dyspnea. Most patients experience immediate improvement. Mean forced vital capacity, mean peak expiratory flow, mean forced expiratory volume in 1 s, and PaO_2 increase after successful stent placement [11,12]. Many patients with an airway obstruction requiring ventilatory support can be separated from the ventilator and have their trachea extubated following the stenting procedure [13,14•].

Expandable mesh metal stents are easier to insert and have a wider internal lumen than silicone stents. Uncovered metal stents do not impair drainage of

sputum because ciliary movement is not interrupted. Expandable metal stents are indicated for unresectable malignant airway disease because, once placed, they are considered permanent. Since they are so difficult to remove they are also less likely than silicone stents to become displaced distally with manipulation of the airway [15]. Their flexibility allows them to be bent so they conform better to tortuous airways than rigid silicone stents.

Over a period of time the metal stent is incorporated into the airway wall and its mesh becomes covered with mucosa. Therefore metal stents may only be temporarily effective for stenosis due to intra-luminal tumor or granulation tissue since both can eventually grow between the wire mesh [16••].

Silicone stents are not intended to be permanent and can be removed or displaced easily. They are used when stenting is intended to be temporary since they can be removed when the stenosing airway disease subsides. Silicone stents are normally used for obstruction due to inflammation and infection [17•]. Anesthesiologists should be aware that the position of a silicone stent, especially one in the trachea, can change during tracheal intubation.

Anesthetic management

Every patient undergoing anesthesia for pulmonary stent placement must have a full preoperative assessment. The foremost concern is the extent of the airway disease. Pertinent information should be obtained by history, physical examination, diagnostic imaging studies and pulmonary function testing.

Inspiratory stridor suggests extra-thoracic obstruction while expiratory stridor is probably due to intra-thoracic obstruction. The location, size and extent of the mass or the degree of airway obstruction should be accurately established by conventional radiography, chest computed tomography and chest magnetic resonance studies. This information will help determine what size endotracheal tube (ETT) to use, the safe depth for ETT placement, and, for high lesions, whether or not an ETT can be used at all. Flow-volume loops can differentiate between a variable and a fixed obstruction. Spirometric pulmonary function tests and an arterial blood sample are also useful.

Sedative premedication should only be considered for a very anxious patient because of the potential for hypoventilation and further airway obstruction. Patients should never be sedated in an unmonitored environment such as the radiology suite where stenting procedures are often performed. An anticholinergic agent can be helpful for excessive airway secretions.

The method of achieving airway control depends on the nature and extent of the patient's airway disease. An 'awake' intubation, a fiberoptic bronchoscope-assisted intubation, or the routine placement of an ETT after intravenous anesthetic induction and muscle relaxation can all be considered. The patient with an anterior mediastinal mass compressing the airways may need to be induced in the sitting position.

An ETT can cause bleeding and aggravate an intraluminal obstruction. For friable tumors in the proximal trachea, we recommend advancement of the ETT over a fiberoptic bronchoscope under direct vision. Once the trachea is intubated there is the possibility that airways distal to the ETT can collapse so a rigid bronchoscope and someone familiar with its use must always be available to re-establish a patent airway if necessary.

A metal stent can be placed under topical anesthesia with or without intravenous sedation. Since an immobile patient is essential for airway measurement, dilatation and accurate stent positioning, general anesthesia is a better choice [18]. The diversity of anesthetic techniques used means that no technique meets all requirements in all patients [19•]. We usually start with an inhalational agent and switch to a short-acting intravenous agent (propofol or remifentanil) to maintain depth of anesthesia during the frequent periods of suctioning, airway dilatation and stenting when ventilation is interrupted.

Stenting procedures require an immobile field for precise airway measurement, so a short-acting neuromuscular relaxant is also used. We prefer succinylcholine. Obviously, if a nondepolarizing relaxant is used it must be fully reversed before extubation.

Jet ventilation can be considered for severe tracheal stenosis since it can provide adequate ventilation with a nonobstructed visual field during fiberoptic bronchoscopy and stent insertion [20••].

Patients requiring general anesthesia usually can have their trachea extubated while still in the radiology suite. Since the potential need for emergency re-intubation is always present, all necessary airway equipment and an endoscopist with bronchoscopy equipment must remain immediately available until the patient is fully awake. If the patient is obtunded and not breathing adequately, or if the airway has been traumatized, the trachea should remain intubated.

Complications

Airway patency can worsen as the patient recovers from anesthesia if the upper airway becomes edematous after the bronchoscope or ETT is removed. Coughing during

emergence can increase bleeding. A tube exchanger placed through a rigid bronchoscope or ETT before airway extubation can be used as a guide for placement of a new ETT if re-intubation does becomes necessary. Tracheostomy may not be feasible, but crico-thyroidotomy is possible through a mesh steel tracheal stent.

A chest radiograph should always be obtained in the postanesthesia care unit. Mucosal perforation or barotrauma may lead to subcutaneous emphysema and tension pneumothorax. There is the possibility of massive hemorrhage with the need for emergency thoracotomy [21]. For procedures with a very high likelihood of serious complications, an operating room should be available and prepared even when the actual procedure is performed at a distant location such as the radiology suite. There may be marked resistance to ventilation from a misplaced or dislodged stent or tumor material.

Stent displacement, mucus impaction, granulation tissue formation, and development of an esophago-airway fistula [22] are potential long-term complications.

Conclusion

Stent placement under general anesthesia is an increasingly popular alternative to surgery for patients with benign and malignant central airway obstruction [23,24]. Every anesthesiologist must be familiar with the different stents currently used, and with the anesthetic requirements for stenting procedures.

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