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REVIEW

Surgically modified airways: What every anesthesiologist should know

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SUMMARY

Airway management is an essential skill for both anesthesia and intensive care physicians. There are well known anatomical changes that alert physicians of a potentially difficult airway. However, there are multiple possible alterations of airway anatomy as a result of either disease, surgical procedures, or both. Familiarity with the unique characteristics of a surgically modified airway is important for safe practice. In this paper, we will summarize a variety of surgical airways and their specific differences from normal anatomy as well as the diagnosis and management of common surgical airway emergencies.

1. Introduction

Challenging airway management remains one of the most concerning tasks in the perioperative period. Failed airway management is considered to be one of the leading causes of poor outcomes in anesthesia, critical care and emergency medicine.[1–3] Failed intubations usually stem from three main causes: patient factors, lack of resources and preparation, and deficient knowledge skills.[4] Patient related-factors are usually defined by the anatomical features and pathological disorders that complicate airway management. Many prediction scores have been developed to predict the airway difficulty, and American Society of Anesthesia algorithms have been made to aid in managing these airways.[5,6] However, there is minimal discussion in the literature on managing surgically modified airways. Surgically modified airways include tracheostomy, laryngectomy, tracheal resection, and oropharyngeal reconstruction. The deficient knowledge of airway anatomy after surgery and the unfamiliarity with airway tools may lead to adverse events.[7]

2. Tracheostomy

Tracheostomy is a very prevalent procedure around 100,000 per year.[8] It is very common to encounter patients with a preexisting tracheostomy in the perioperative period undergoing an unrelated surgical procedure, in an emergent situation when an advanced airway is required, or in the critical care unit. Anesthesiologist management of tracheostomy patients should include knowing the indication for tracheostomy, the surgical approach, the age of stoma, the type of tracheostomy tube, and management of tracheostomy emergencies.[9,10] This management is demonstrated in Table 1. The Indication for tracheostomy points at the underlying pathology and the postoperative airway anatomy.

2.1. The surgical approach

The technique used to create the tracheostomy affects the maturation time of the stoma, the risk of tracheostomy tube displacement, and the problems associated with both tracheostomy tube reinsertion and endotracheal intubation. There are two main methods for tracheostomy, the percutaneous dilatational tracheostomy (PDT) and the traditional open surgical (OS) method.

The PDT technique is performed using Seldinger technique, usually with fiberoptic bronchoscopic guidance. The advantage of PDT is that it can be done relatively quickly, and is frequently performed at bedside in the intensive care unit. PDT is usually used for adult intubated patients with normal airways after excluding any patient with previous neck surgery, tracheal deviation, or thyromegaly. The risk of postoperative bleeding complications and infection is less compared to open surgical approach.[11] The stoma usually is very tight which make the risk of tube dislodgement less,

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Table 1
Intubation options for tracheostomy patients.

Factors favoring orotracheal intubation:
Fresh stoma
Percutaneous approach
Easy airway
Factors favoring tracheostomy tube reinsertion:
Stoma age >14 days
Open technique
Stay sutures
Total laryngectomy/Occluded airway
Awake tracheostomy(indicates difficult airway)

but the resulting tissue collapse and small resulting tract after a tube is dislodged will make it more difficult to be reinserted. In an emergency situation, the orotracheal route for securing the airway should be used whenever possible.[12,13]

The OS is an option for all airways, including the difficult airway anatomy. Dissection allows full evaluation of the trachea and direct visualization during the creation of the stoma. There are some differences in surgical techniques which can facilitate tube reinsertion in case of accidental tube decannulation. These modifications include the Björk flap and stay sutures. The Björk flap creates a tracheal flap that is then secured to the subcutaneous tissues, creating an easy path for tube exchange. Stay sutures are placed into the trachea during the procedure and are kept in place, and act as a marker of the tracheostomy tract.[12,14,15]

Regardless of the technique used, tracheal stomas need ten to fourteen days to mature. Any dislodgment of the tube before stoma maturation is an emergency.[16,17] The blind reinsertion of a tube in a fresh stoma may end up creating false passage with serious complications like subcutaneous emphysema, pneumomediastinum, or death. The risk of false passages is higher in obese patients, short neck, and sequelae of the percutaneous approach. Anesthesiologists should follow a clear strategy to manage the dislodged tube.

There are different types of tracheostomy tubes used for a variety of clinical and anatomic reasons. Generally, a cuffed tracheostomy tube is used in patients undergoing a procedure in which an endotracheal tube would normally have been placed (e.g. general anesthetic). Additionally, a 15 mm connector should be used when providing positive pressure ventilation.[18]

2.2. Tracheostomy emergencies

Tracheostomy emergencies are those that lead to airway loss or hypoxemia, including accidental decannulation, tube obstruction, bleeding due to a tracheo-innominate artery fistula, and negative pressure pulmonary edema.

2.2.1. Tracheostomy bleeding

The most serious tracheostomy-related bleeding is bleeding secondary to tracheo-innominate artery fistula (TIF). The incidence of TIF is 0.3%, but the mortality rate remains high, and can approach 100% without prompt intervention. The peak incidence of TIF is between the second and the third postoperative weeks. As the role of the anesthesiologist is expanding to critical care medicine, it is crucial to know the initial management of this event. The first step in TIF management is to confirm airway as the source of bleeding by bronchoscopy. Efforts should then focus on temporarily controlling the bleeding until definitive control can be obtained, often by an operation, and a secure airway should be obtained. Hyperinflating the tracheostomy cuff will often tamponade, or slow, bleeding. Failure to obtain control by tracheostomy cuff hyperinflation requires orotracheal intubation with cuff inflation beyond the tracheostomy stoma. The tracheostomy tube should then be removed and the provider should insert their finger through the stoma, bend their finger anteriorly in either the tracheal or pre-tracheal space, and compress the innominate artery against the posterior wall of the manubrium in order to tamponade the bleeding. Bronchoscopy should then be used in an attempt to clear the airway of blood. These interventions aid in arresting the bleeding in 80% of cases, however the definitive therapy is surgical exploration and TIF repair.[19,20]

2.2.2. Accidental tube dislodgement

The incidence of a dislodged tracheostomy tube is low, but is associated with high mortality rates.[21] Tracheostomy tube dislodgement may occur during patient transfer to various diagnostic or therapeutic procedures, in patients with inadequate sedation allowing for excessive movement or coughing, or even during routine nursing care. Other risk factors for tube dislodgement include patient obesity and short neck.[9,10] The plan for managing the dislodged tube is based on three factors, the patency of the upper airway, the age of the stoma, and the surgical technique used in creating the tracheostomy.

For emergency situations, especially when the patient's history is unknown, mask ventilation should be applied to both the upper airway and to the tracheostomy stoma. Mature stomas (tracheostomy age more than 10 days) are generally safe for the provider to reinsert the dislodged tube. If the stoma is fresh (tracheostomy age less than 10 days), the orotracheal intubation route should always be attempted first as reinsertion of fresh stoma may lead to false passage. Tracheostomy created by PDT favors the use of the orotracheal intubation route as it difficult to reinsert the tube without creating a potential false passage. In the OS method, stay sutures aid in re-insertion the tracheostomy tube.[14,21] Patients who have an obstructed or surgically absent upper airway mandate immediate attempts to reinsert the dislodged tube.

If attempts to secure the airway by orotracheal methods fail, reinsertion of the tracheostomy tube should be guided by fiberoptic bronchoscope, fiberoptic bougie catheter, or a small nasogastric tube used with Seldinger technique. Soft catheters are preferred over hard forceful insertion which may create a false passage.[22,23] Table 1 and Fig. 1 demonstrate our management strategies for tube dislodgement.

2.2.3. Negative pressure pulmonary edema

Negative pressure pulmonary edema is well described and presents after relief of airway obstruction.[24] This complication may occur after creating a tracheostomy and the subsequent relief of obstruction that may result in hypoxemia and requires supportive therapy.[25]

3. Laryngectomy

Laryngeal cancer can be treated by a variety of surgical resections, radiotherapy, or chemotherapy, and often in combination as multimodal therapy. Early stage cancers are usually treated by laryngeal preservation surgery, known as partial laryngectomy. Total laryngectomy is indicated for advanced stages of laryngeal cancer, or in patients who have failed conservative therapy. However, partial laryngectomy with adjuvant radiotherapy still can be offered for selected advanced cancers.[26] Patients with previous laryngectomy of any type usually present with a tracheostomy and distorted airway anatomy secondary to surgical and radiotherapy effects.

The most critical step in airway management of laryngectomy patient is to identify the surgical approach used; either partial or total laryngectomy. In total laryngectomy, the tracheal stump is anastomosed to the neck anteriorly with a resultant permanent