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Pediatric tracheostomy

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ABSTRACT

Tracheotomy refers to a surgical incision made into a trachea. *Tracheostomy*, on the other hand, refers to a surgical procedure whereby the tracheal lumen is positioned in close proximity to the skin surface. Tracheostomy is an uncommon procedure in the pediatric population. When required tracheostomy is typically performed as an open surgical procedure under general anesthesia with the patient intubated. However, it may need to be performed under local anesthesia or over a rigid bronchoscope in the patient with a precarious airway. Over the past half century, the primary indication for pediatric tracheostomy has shifted from acute infectious airway compromise to the need for prolonged ventilatory support in neurologically compromised children. The surgical technique, choice of tracheostomy tube, and post-operative care requires a nuanced approach in infants and young children. This article will review these topics in a comprehensive fashion.

Indications for tracheostomy in children

In adults and children, the *indications* for tracheotomy include (1) a means to bypass an acute or chronic upper airway obstruction; (2) facilitation of the care of patients requiring long-term ventilatory support; (3) protection from aspiration by providing access for tracheobronchial toilet; (4) prevention of laryngotracheal stenosis in patients requiring long-term intubation; and (5) facilitation of weaning from a ventilator by eliminating ventilatory dead space. In children, common indications for tracheostomy include congenital and acquired airway stenosis, neurologic conditions requiring long-term ventilation or pulmonary toilet, bilateral vocal fold insufficiency, and infectious compromise of the upper airway.[1–4]

In 1988, Arcand and Granger[5] reported their experience with pediatric tracheostomy at a single institution over two consecutive decades. This group observed a marked reduction in the overall number of tracheostomies with a shift in the primary indication from acute airway obstruction due to an infectious etiology to congenital airway abnormality. Wetmore et al.[6,7] reported in two separate studies the Children's Hopsital of Philadelphia long-term experience with pediatric tracheostomy from 1971–1992. A similar decreasing trend in the total number of tracheostomies performed per year was observed along with an increase in long-term tracheostomies.

In 1988, Crysdale and colleagues analyzed the Hospital for Sick Children (Toronto, Canada) experience in pediatric tracheostomy and compared their findings to a similar study from the same institution performed 15 years earlier by Friedberg and Morrison.[8,9] Once again, they noted a decline in the number of tracheostomies performed per year and a shift in primary indication away from acute airway obstruction due to infection. These studies have demonstrated that within a single institution the average number of tracheotomies per year had decreased by half. This decline was attributed mainly to a change in the management of supraglottitis.

A more recent audit of tracheostomy practice at the Hospital for Sick children suggests a further decline in the number of tracheostomies required (unpublished data) (Figure 1). Factors that have sustained the trend of a decrease in the total number of tracheotomies performed per year include (1) the introduction of the Hib vaccine in Canada in 1988 and the resulting decrease in cases of epiglottitis, (2) the decrease in the number of patient referrals to our institution, since 2000, as other regional centers in Ontario established tertiary pediatric care, (3) technological improvements in ICU care settings with non-invasive ventilatory assistance, (4) the use of flexible endoscopes for securing the airway in patients requiring advanced craniofacial surgery, and (5) a more comprehensive discussion about withdrawal of care in complex patients. However, there has been a significant increase in the number of tracheostomies performed for long-term mechanical ventilation

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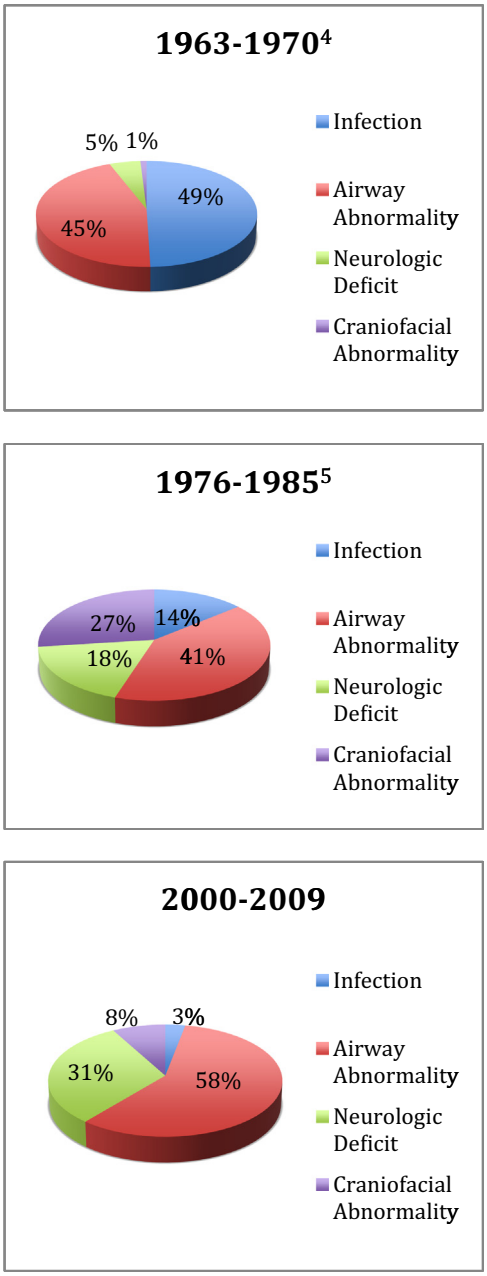

Fig. 1. Indications for tracheostomy at the Hospital for Sick Children (Toronto, Canada) between 1963 and 2009.

in patients with neurologic conditions. This observed "shift" in surgical indication has decreased decannulation rates because of the need for prolonged ventilatory support.

Complications: Intra-operative, early, and late post-operative

The surgical *complications* associated with tracheostomy can be classified temporally as occurring in the intra-operative period, early post-operative (first 7 days), and late post-operative periods (after 7 days or after the first tracheostomy tube change) (Table 1).

A review of the literature of pediatric tracheostomy (Table 2) reveals a complication rate ranging from 10% to 58% and a mortality rate ranging from 0% to 3.6%. Meticulous attention to the pre-operative evaluation, the surgical technique, selection of tracheostomy tube, and post-operative care are key to minimizing the risk of morbidity and mortality. These topics will be addressed in the remaining sections of the article.

Pre-operative evaluation

A thorough pre-operative evaluation of the patient is required to confirm the appropriateness of the decision to proceed with tracheostomy. This includes a review of the overall medical status of the patient as well as a detailed examination of the entire airway from the nasal cavity to the distal bronchi. The examination may reveal secondary areas of obstruction that if corrected may prevent the need for tracheostomy. In addition, the examination will provide reassurance that the tracheostomy will indeed bypass the area of obstruction (when obstruction is the indication for the procedure).

Examination of the external neck provides an estimate of the complexity of the procedure to be undertaken. An inability to palpate airway landmarks, the presence of external scars from previous neck and chest surgery, or the palpation of arterial pulsations above the sternal notch are indications of potential hazards that may be encountered during the procedure.

The cardiorespiratory status of the patient must be evaluated by the appropriate medical services (critical care, anesthesia, respiratory medicine, and cardiology) to ensure that the patient is medically optimized for the anesthetic and surgical challenge. Moreover, a medical assessment may help to anticipate post-operative complications such as post-obstructive pulmonary edema, or loss of respiratory drive in chronically hypercarbic patients.

Surgical technique

As with any surgical procedure, a surgical checklist should be used to ensure that all necessary equipment and a range of tracheotomy tube sizes are available and functioning properly prior to commencing the procedure. A detailed intra-operative airway management plan should be established with the anesthesia and nursing teams prior to bringing the patient into the operating theater. In addition, during the procedure there should be ongoing communication between the surgeon and anesthetist to ensure control of the airway.

The patient should be placed in the supine position with a rolled towel placed under the shoulders to maintain the neck in extension. The surface landmarks of the neck should be palpated to locate the thyroid cartilage, cricoid cartilage, and suprasternal notch. The surgeon should also palpate for prominent vascular pulsations suggestive of a high-riding innominate artery. The surgical site can then be prepared and draped in sterile fashion.

Step 1

Palpate the surface landmarks to identify the cricoid cartilage and sternal notch. A horizontal incision is made midway between these two landmarks. This location would typically correspond with the second and third tracheal rings. Infiltrate the skin and subcutaneous tissues with a local anesthetic with adrenaline. This will minimize bleeding during the procedure and will blunt any patient response to stimulation when dissection approaches the trachea.

Step 2

Following the horizontal skin incision, the deeper fat and platysma layers are transected in the horizontal plane, and