Pediatric Airway Surgery

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Direct Laryngoscopy and Rigid Bronchoscopy

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\textbf{Abstract}

Laryngoscopy and rigid bronchoscopy represent a necessary tool in the otolaryngologist’s arsenal. The advancement in designing smaller and more versatile laryngeal equipment and fiber-optic telescopes as well as the increasingly higher resolution of still and video imagery have allowed otolaryngologists to better diagnose and treat many airway lesions. This chapter describes the basic equipment necessary as well step-by-step description of the technique to perform rigid airway endoscopy.

Endoscopy has become an invaluable tool to the aerodigestive surgeon. Since its early beginnings with German physician Philipp Bozzini (1773–1809) and his ‘Lichtleiter’ (‘light guide’ – a double cannula with internal mirror device using candle light to allow inspection of the larynx), endoscopists have pushed the envelope to better see and understand the aerodigestive tract \([1]\). Soon others followed: Manuel Garcia (1805–1906) pioneered autolaryngoscopy; Dr. Alfred Kirsten (1895) moved away from indirect mirror laryngoscopy with direct visualization of the larynx; Dr. Gustav Killian (1911, ‘Father of Bronchoscopy’), with the advent of suspension, made bimanual manipulation of the larynx possible; from this point in Philadelphia, Dr. Chevalier Jackson (‘Father of American Bronchoesophagology’) began his practice and would then train Dr. Paul Holinger, father and mentor of Dr. Lauren Holinger.

In the 1930s and 1940s, Dr. P. Holinger along with photographic engineers James and Joseph Brubaker successfully developed the first handheld endoscopic camera. In 1941, they produced the first high-quality film of the bronchial tree and then the first high quality photos of the larynx. Please note this list of notable physicians does not include all those (physician and scientists) that pioneered the technology of endoscopy, names like Nitze, von Mikulicz, Fourestier, Lamm, van Heel and Hopkins. Since then, the evolution of technology and innovation has produced even smaller and more versatile instruments, telescopes and cameras allowing endoscopists to better evaluate, diagnose and treat pediatric aerodigestive disorders.

Both flexible and rigid bronchoscopy are necessary procedures in order to fully evaluate the pediatric airway. Advantages of rigid bronchoscopy include the ability to ventilate while performing bronchoscopy, which is helpful for patients with...
poor pulmonary reserve, as well as superior optics and resolution. Flexible bronchoscopy allows for visualization and access to the smaller airways and the ability to perform diagnostic procedures (i.e. bronchoalveolar lavage). Also of significance is the evaluation of tracheo- and bronchomalacia. Flexible bronchoscopy is superior to rigid bronchoscopy in the evaluation of malacia by giving the endoscopist a dynamic view of the airway during respiration. Rigid bronchoscopy artificially stents the airway open during the procedure giving the endoscopist a false sense of airway patency.

Performing both flexible and rigid bronchoscopy is complementary adding the collective benefits together to gain a better understanding of the pathology. Additionally, with the addition of a pulmonologist to the 'team', broader differentials can be entertained to achieve the correct diagnosis. In this chapter, the authors will describe their technique for evaluation of the pediatric larynx, trachea, and bronchi to include some instruments and pearls necessary for success.

Relevant Anatomy

For relevant anatomy, see the Laryngeal Development and Anatomy chapter.

Indications

- SPECSR acronym [2]
  - Severity: subjective impression from parents/guardian
  - Progression: the lesion has become larger over time
  - Eating: feeding difficulties, concern for aspiration, weight loss
  - Cyanotic episodes: Child turning blue or apparent life-threatening events
  - Sleep: obstructive symptoms while sleeping (i.e. retractions)
  - Radiology: findings on radiographs suggestive of an airway lesion.
  - Concerning findings on office-based flexible fiber-optic laryngoscopy

Contraindications

Significant subglottic stenosis where any instrumentation of the airway at the point of the stenosis may cause imminent respiratory compromise

Anesthesia Considerations

- Open and ongoing dialogue with the anesthesiologist
  - The table and the patient's airway are turned over to the endoscopist during the procedure. Allowing the anesthesia provider to see the video display can help them understand the nuances of the case so they can maintain the correct plane of anesthesia.
  - If a ventilating bronchoscope is utilized, switching the anesthesia circuit will be necessary during the case
  - A one-time dose of dexamethasone 0.5 mg/kg up to 10 mg

Preparation

- Equipment needed:
  - Straight blade laryngoscope (Miller or Parsons)
  - The straight blade laryngoscopes allow safe and straight passage of the telescope or rigid bronchoscope through the laryngeal inlet without local tissue damage or bending of the telescope
  - Basic pediatric rigid bronchoscopy set (fig. 1)
  - Lindholm vocal cord and false cord retractor (Karl Storz, Germany; fig. 2)
Infant, child and adult Lindholm laryngoscopes (Karl Storz) with Benjamin suspension and chest support (Karl Storz)

- Need for a shoulder blade depends on patient age (see figure 1 of the Endoscopic Posterior Cricoid Split with Rib Grafting chapter)

Procedure

- After general mask induction using sevoflurane and gaining intravenous access, the operating room table is turned 90° towards the endoscopist
- If the patient has erupted dentition, a tooth guard is utilized on the anterior maxillary teeth
• An appropriate-sized straight blade laryngoscope (either a Miller or Parsons) is placed into the vallecula and the larynx is exposed
• 2 or 4% lidocaine (depending on the child’s age and weight) is topically applied with an atomizer to anesthetize the vocal folds and any secretions present are suctioned using a laryngeal microsuction (with thumb suction control)
• The 0° 4 mm × 18 cm Hopkins rod-lens telescope with attached HD camera head is used to evaluate the supraglottis, glottis, subglottis, trachea and primary bronchi (online suppl. video 1)
  – It is the authors’ preference to use just the 4-mm telescope if possible in order to achieve the highest resolution image and video. Additionally, it is less bulky when held in the surgeon’s hand, and since it is narrower than its associated ventilating bronchoscope, it has the potential for less local tissue irritation and swelling.
  – However, if there is any airway concern for stenosis, or it is an unknown airway with risk of rapid respiratory compromise, a smaller rod-lens telescope may be needed. (0° 2.7 mm × 18 cm, 0° 1.9 mm × 18 cm). Additionally, we have a needle tracheostomy (fig. 3) and tracheotomy set open on the back table prior to starting the procedure as well as a 3.0 or 2.5 endotracheal tube placed over a 1.9-mm Hopkins rod-lens scope (used in a Seldinger fashion) in case there is any airway emergency (fig. 4).
If the patient is a neonate or premature with little pulmonary reserve we use an appropriate-size ventilating bronchoscope initially and forgo using just the rod-lens telescope.
- If bimanual dexterity for diagnosis or performing a procedure (microlaryngology) is needed, we place the patient into suspension using the Lindholm laryngoscope/Benjamin suspension and chest support (fig. 5).
- The Lindholm vocal cord and false cord retractor is an essential tool for airway evaluation (see the Vocal Fold Retractor video in the Recurrent Respiratory Papillomatosis chapter). It can help with diagnosis and treatment of the following lesions:
  - Laryngeal cleft (fig. 6)
  - Recurrent respiratory papillomatosis (fig. 7)
  - Glottic webs
  - Subglottic stenosis (fig. 8)
  - Proximal tracheal lesions (fig. 9)
  - Airway hemagioma (fig. 10)
  - Pyriform sinus tracts

**Postoperative Care**
- Depending on other comorbidities (syndromic features, craniofacial dysmorphisms, significant airway stenosis), the patient usually can be discharged the same day as long as he/she is meeting discharge criteria.
If the patient has significant chronic pulmonary disease, severe asthma, concerns for obstruction after anesthesia, there is a low threshold to observe them overnight.

Patients with a tracheotomy usually can be discharged the same day.

- There is minimal pain from this procedure, and most children do well with acetaminophen if any pain medication is required.

**Pearls**

- Constant dialogue with your anesthesia provider
- Use of an appropriate-size ventilating bronchoscope if there is poor pulmonary reserve
- If there is any concern for airway stenosis, or it is an unknown airway with risk of rapid respiratory compromise, a smaller rod-lens telescope may be needed. (0° 2.7 mm × 18 cm,
0° 1.9 mm × 18 cm). If the smaller scopes do not pass easily, it is unwise to attempt to force through the stenosis as this may turn a stable airway into an unstable one due to resulting edema.

- Having several airway adjuncts ready in case of airway compromise
  - The laryngeal mask airway can be very helpful in a situation of difficult ventilation
  - Placing a 3.0 or 2.5 endotracheal tube over a 0° 1.9 mm × 18 cm Hopkins rod-lens telescope can be a helpful way to establish a secure airway under direct vision using a Seldinger technique in an emergent airway situation
  - Making a needle tracheotomy set and having it ready in case of airway emergency
  - A tracheotomy set open on the back table if the surgeon feels an emergent surgical airway might need to be established

Fig. 10. Airway hemangioma.

References