SUPRAGLOTTOPLASTY

Surgical Specialty:	Otolaryngology
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Background:

- General Considerations
  - Laryngomalacia (LM) is the most common laryngeal anomaly and cause of stridor in newborns.[1-4] While LM has be reported in older children, it most frequently occurs in infants.
  - The typical presentation of LM is stridor and upper airway obstruction that is worse with agitation, crying, and feeding. LM is characterized by reduced laryngeal tone and supraglottic airway collapse. This can vary in presentation from mild noisy breathing to life-threatening upper airway obstruction and failure to thrive from feeding difficulties.[1,5]
  - Most cases are mild or moderate and respond to conservative medical therapy with resolution by 12-24 months. Approximately 20% of infants with severe disease will require surgery.[5]
  - Supraglottoplasty can include the release of aryepiglottic folds, trimming of supra-arytenoid mucosa, and/or trimming of the lateral epiglottis (Figure 1).
  - Surgery is performed endoscopically with a CO_2 laser, a microdebrider, or microlaryngeal instruments. Many centers have moved to the cold technique to avoid airway fires and to decrease the likelihood of laryngeal edema and post-operative feeding issues that may occur with the use of the CO_2 laser.
  - The surgical case is short, typically lasting less than an hour.
- Patient Considerations
  - Disease Specific Considerations
    - Gastroesophageal reflux occurs in up to 80% of infants with LM and can manifest as feeding intolerance, aspiration, or failure to thrive.
  - Associated Comorbidities/Syndromes
    - Additional airway lesions may co-exist and need to be investigated during evaluation under anesthesia prior to intervention.
    - Synchronous airway lesions are more frequent in infants with severe laryngomalacia, premature infants with laryngomalacia, and infants with comorbidities (genetic, cardiac, or neurologic conditions)

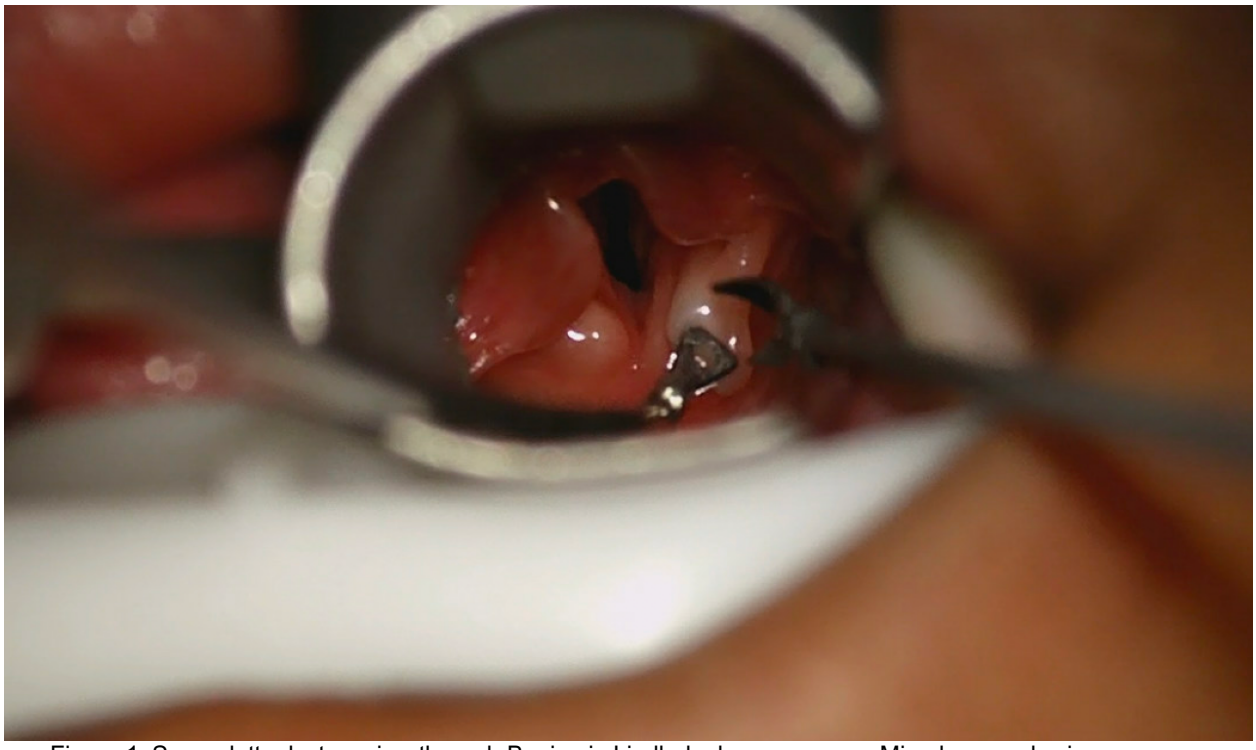

Figure 1: Supraglottoplasty – view through Benjamin Lindholm laryngoscope. Microlaryngeal scissors are being used to trim excess tissue.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - Many patients will have had flexible fiberoptic laryngoscopy in the clinic.
  - A history of prematurity can adversely affect the control of ventilation during deep anesthesia and post-operatively.
  - Complementary studies to uncover concomitant congenital cardiac, neuromuscular disease, or gastrointestinal disorders are part of the evaluation of children with LM.
  - Discussions to have with surgeon/family:
    - Patients may require intensive care unit (ICU) admission post-operatively.
    - Most patients do not require post-operative intubation.
- Specific or Unique Room Set-Up Requirements
  - Airway
    - There is a shared open airway during the procedure.
    - Cuffed and uncuffed endotracheal tubes (ETT) of multiple sizes.
    - Other airway equipment should be available, including supraglottic airways and oral airways, as clinically indicated.
  - Drugs/Infusions
    - There are many options for maintenance and institutional practice will vary:
      - Sevoflurane
        - The most commonly used volatile agent. Its favorable blood gas solubility allows for rapid titration.
        - At 1.0 minimum alveolar concentration (MAC), sevoflurane has been shown to be superior to desflurane for suppressing moderate and severe responses to tracheal stimulation.[6]
        - Volatile agents are potent greenhouse gases, and operating room (OR) contamination is a risk with an open airway.

        - Un-scavenged waste anesthetic gases can result in chronic occupational exposure of healthcare workers and potential adverse health effects.
        - With an open airway, volatile agent alone may not provide a stable plane of anesthesia.
    - Ketamine boluses (1 mg/kg)
        - The authors' preferred intravenous (IV) medication in infants.
        - It maintains hemodynamics, which can suffer from the use of sevoflurane as a sole agent.
        - It does not depress the respiratory drive.
        - May require co-administration of an anti-sialagogue such as glycopyrrolate 5 mcg/kg.
        - Consider the addition of midazolam to mitigate dysphoria or hallucinations in older children.
    - Dexmedetomidine bolus (0.5-1 mcg/kg over 10 minutes) or infusion (0.3-1.5 mcg/kg/hour)
        - Causes little to no respiratory depression
        - Transient hypertension can be seen after a bolus, but the most common side effects are bradycardia and hypotension.
    - Propofol boluses (0.5-1 mg/kg) or infusion (50-200 mcg/kg/min)
        - Boluses can quickly increase the depth of anesthesia if needed but may compromise spontaneous ventilation.
        - An infusion can supplement the anesthetic and reduce patient movement.
    - Opioids
        - Fentanyl
            - Judicious dosing is needed to maintain spontaneous ventilation.
            - Chest wall rigidity may occur in pediatric patients even after low-dose fentanyl, though rare.
        - Remifentanil
            - Rapid onset and recovery which is desirable as the procedure can have periods of low/no surgical stimulation interspersed with periods of high stimulation.
            - Maintaining spontaneous ventilation can be challenging with remifentanil.
        - Other longer acting opioids, such as morphine or hydromorphone may be used, but this procedure is short and is not very painful post-operatively.
        - An opioid infusion is usually unnecessary.
    - Dexamethasone (0.5mg/kg up to a max of 10mg) to reduce perioperative edema
    - Topical local anesthetic to apply to the vocal cords to blunt the effects of stimulation. This is typically lidocaine 0.5% or 1% 0.5-1mL. Caution is needed to not exceed the maximum dose in a neonate.
- Monitors
    - Standard American Society of Anesthesiologists monitors
    - Gas monitoring will not be accurate with an open airway
- Blood availability: not generally needed

- ICU bed availability: may be required, particularly for the former preterm infant or those with co-morbidities.

Intraoperative Considerations:

- General
  - Anesthetic goals include maintaining spontaneous ventilation, immobility, and hemodynamic stability.
- Induction
  - Inhalational induction is usually well tolerated in the absence of cardiac disease.
- Positioning
  - Supine position with the patient in laryngeal suspension (Figure 2).
  - The OR table is turned 90 degrees to give room for the equipment needed for the procedure. In addition to the airway equipment for microlaryngoscopy, a microscope is needed for the supraglottoplasty (Figure 2).

Figure 2: The Parsons laryngeal suspension apparatus. Clear plastic draping allows visualization of the chest while preventing hypothermia. The microscope is in the foreground and the view is projected onto additional screens for other staff in the room.

- Maintenance
  - Sevoflurane is delivered by insufflation via a ventilating side port or a small ETT in the patient's nose or mouth. Figure 3 demonstrates different airway insufflation techniques.

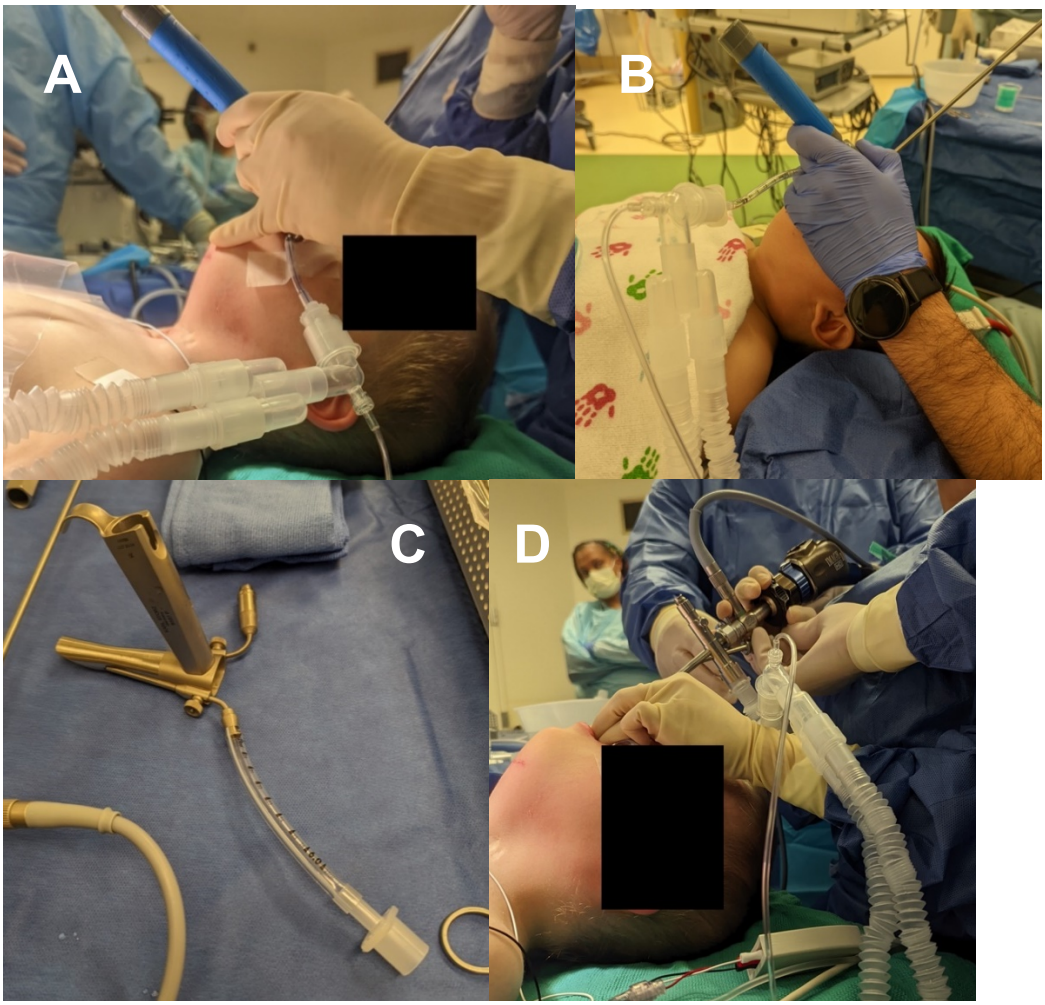

Figure 3A-D.: Different techniques for airway insufflation. A. Oropharyngeal airway insufflation via an oral RAE taped to the corner of the mouth. B. Oropharyngeal airway insufflation via a straight ETT held by the surgeon C. Laryngoscope with cut 6.0 ETT attached to ventilating side port. D. Flexible circuit adapter attached to the ventilating side port of a bronchoscope.

    - A balanced anesthetic: sevoflurane should be supplemented with IV agents such as propofol, ketamine, dexmedetomidine and/or an opioid.
        - Can improve ventilation and maintain hemodynamics.
        - Reduces OR exposure to waste gases
    - If a CO_2 laser is used, standard precautions should be taken (e.g., reduce FiO_2 in the surgical field; if the patient is intubated, consider a laser-safe ETT; safety glasses for staff; adequate smoke evacuation; implement measures to reduce laser-related soft tissue injury).
- Hemodynamic/Physiologic goals
    - Maintenance of normal blood pressure may require support with vasoactive agents (e.g., ephedrine, phenylephrine, or in some cases, low dose epinephrine either by infusion or bolus).
    - Spontaneous ventilation is preferred.
    - If the blood pressure is low or if controlled ventilation is necessary, then a muscle relaxant may be used with intermittent intubation and ventilation between periods of surgical activity.

- Surgical Considerations
    - Bleeding should be minimal even with the cold knife technique. Topical oxymetazoline or epinephrine is generally sufficient
    - Surgeons may prefer to avoid intubation during the procedure for better visualization. However, intubation may be necessary for unstable patients or patients with poor reserve.
    - A muscle relaxant is generally not needed.
- Emergence/Disposition
    - Depending on co-morbid conditions, patients may not require intubation post-operatively, but will require close monitoring for airway edema and obstruction.
    - Some patients are appropriate for the floor, while others may need PICU or step-down care.
- Post-operative Care
    - Pain can be managed with acetaminophen and NSAIDs.

Case Specific Complications/Pitfalls

- The inability to monitor minute ventilation, end tidal CO_2, and the exhaled anesthetic concentration during airway insufflation necessitates paying close attention to the patient.
- Watch the patient's chest for respiratory patterns to monitor for signs of airway obstruction, apnea, or light anesthesia.
- The delivery of volatile anesthetic to the patient is unpredictable, thus IV medications are usually necessary to maintain an adequate depth of anesthesia.
- Be aware of changing surgical conditions. Laryngospasm can occur from light anesthesia during stimulating parts of the procedure, necessitating the use of propofol or succinylcholine.
- There is a risk of airway fires with the use of CO_2 laser.

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