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DIRECT LARYNGOSCOPY AND BRONCHOSCOPY

Surgical Specialty:	Otolaryngology/Ear, Nose, and Throat Surgery (ENT), Pulmonology
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Background:

- General Considerations
  - Direct laryngoscopy and bronchoscopy (DLB) are commonly performed under general anesthesia to evaluate the upper and lower airway.
  - The procedure involves a shared airway requiring close communication with surgeons throughout.
  - DLB is frequently performed in conjunction with other procedures such as bronchoalveolar lavage and esophagogastroduodenoscopy, and this impacts anesthetic planning.
  - DLB frequently includes airway instrumentation by the surgeon in the absence of endotracheal intubation ('tubeless' technique).
  - Episodes of coughing, laryngospasm, apnea, and oxygen desaturation are common[1]
  - The procedure may include diagnostic evaluation as well as therapeutic interventions such as laser treatment, injection, supraglottoplasty, or tumor removal.
- Patient Considerations
  - DLB is performed on a wide age range of patients from pre-term neonates to adult-sized teenagers.
  - This may present within an elective and or urgent context
    - Urgent procedure in trauma, mechanical obstruction from infection, foreign bodies, tumor, or vascular malformations
    - Elective procedure to evaluate the anatomy in craniofacial disorders, airway anomalies (laryngeal cleft, tracheomalacia), neuromuscular disease, metabolic disorders, airway neoplasms, iatrogenic conditions (intubation trauma, subglottic stenosis)
  - Associated comorbidity may exist, such as cardiac, pulmonary, neurologic, and metabolic disease, and should be actively considered during the anesthetic planning.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
  - History-taking should focus on upper and lower airway respiratory symptoms, recent illnesses, postural preferences, prior surgeries, intensive care admissions, nocturnal symptoms and prior anesthetics.[2]
  - On exam assess for signs of respiratory distress, stridor, voice changes, postural changes in symptoms, dysmorphic features, and mandible size.
  - Chest X-Ray and occasionally CT scans of neck and chest may be indicated in the presence of masses causing airway compression.
  - Discussions to have with surgeon/family
    - The possibility of postoperative ventilation/ICU care
    - During the time-out, the planned technique should be discussed including whether tubeless with spontaneous ventilation or apneic oxygenation will be used.
    - The method of oxygenation should be established.
    - Backup plans for oxygenation and ventilation should the initial plan fail.
    - ECMO candidacy, especially in children with significant subglottic pathology.

- Specific or Unique Room Set-Up Requirements
  - Airway
    - Standard airway equipment, including size-appropriate oral and nasal airways, cuffed and uncuffed endotracheal tubes and supraglottic airways.
    - Advanced airway equipment such as video laryngoscope, flexible fiberoptic bronchoscope, and fully assembled rigid bronchoscope with a side port for ventilation and oxygenation.
    - Mucosal atomizer spray or similar device to topicalize the airway under direct vision.
  - Supplemental oxygenation
    - This may be achieved by nasal cannula (traditional or high flow), modified nasal airway (endotracheal tube connector inserted into nasal airway connected to anesthesia circuit), or endotracheal tube placed in the corner of the mouth and attached to the anesthesia circuit.
    - The anesthesia circuit may be connected to the side port of the rigid bronchoscope to insufflate oxygen.
  - Drugs/Infusions
    - Several options/combinations exist for maintenance, which is usually total intravenous anesthesia
      - Inhalational agents
        - Inconsistent delivery during open airway cases

        - Contaminates operating room (OR) environment.
    - Propofol
        - Used as a bolus and/or infusion (50-350 mcg/kg/min).
        - Wide infusion range depending on co-administered drugs.
        - Usually used in combination with other medications.
    - Ketamine
        - 0.25-1mg/kg boluses.
        - Requires glycopyrrolate to prevent excessive salivation.
        - Tends to prolong emergence.
    - Opioids
        - Fentanyl
        - 0.25-0.5 mcg/kg boluses
        - Increases risk of apnea
        - Remifentanil
        - 0.05 -0.15 mcg/kg/min
        - Increases the risk of apnea
        - Requires adequate onset time prior to airway instrumentation.
    - Dexmedetomidine
        - Use as bolus (0.2mcg/kg) and/or infusion 0.3-1mcg/kg/hr
        - Prolongs emergence time and may cause hypotension.
    - Dexamethasone
        - 0.5-1mg/kg to prevent airway edema.
        - Maximum dose 12mg.
    - Lidocaine
        - Direct spray to vocal cords/
        - Maximum dose 4mg/kg.

- Monitors
    - Standard American Society of Anesthesiologists monitors
    - End-tidal carbon dioxide is unreliable in natural airway cases
    - Ensure close clinical monitoring of abdominal and chest movements and perform chest auscultation as necessary.
    - Pay special attention to the direct view of the larynx and airway on the surgical video screen.
    - Ensure a warm room and temperature monitoring as patients are frequently exposed to allow clinical monitoring.

- PICU Bed Availability (if indicated)
- Other Indicated Resources (e.g. ECMO standby)

Intraoperative Considerations:

- General
    - Spontaneous ventilation is key to maintaining adequate oxygenation and to avoid frequent interruptions to ventilate the patient.
    - Attempt a stimulating maneuver such as jaw thrust prior to airway instrumentation to ensure that the patient has reached adequate anesthetic depth.
    - Inadequate anesthetic depth increases the risk of laryngospasm, breath holding, coughing and desaturation.

- Induction
  - Inhalational induction is safe, provided there are no indicators of difficult mask ventilation.
  - Intravenous induction is indicated when there is concern for difficult ventilation.
  - Plan for gradual titration of medications that minimally depress respiration.

- Positioning
  - The patient may be turned 90 degrees away from anesthesiologist.
  - A roll is often positioned under the neck and shoulders to achieve moderate extension of the neck while ensuring that the occiput is still maintaining contact with bed.
  - The patient's eyes should be padded and protected.
  - A bite block may be inserted by the surgeon to protect the upper teeth.

- Maintenance
  - Propofol infusion is used in the vast majority of cases with intermittent bolusing/titration of the adjunct medications listed above.
  - Ensure adequate, uninterrupted supplemental oxygenation.

- Oxygenation and Ventilation Methods[3]
  - Spontaneous breathing without an endotracheal tube
  - Positive pressure ventilation via an endotracheal tube (continuous or intermittently inserted).
  - Jet ventilation
  - Ventilation via the side port of the rigid bronchoscope.
  - Apneic oxygenation with humidified high flow nasal supplemental oxygenation.
  - Nasal continuous positive airway pressure (CPAP).

- Physiological Goals
  - Maintain spontaneous ventilation in 'tubeless' techniques.
  - True apneic oxygenation is acceptable for short periods but results in an uncontrolled rise in arterial carbon dioxide without accurate end-tidal monitoring.
  - Adequate anesthetic depth may result in hypotension which should be corrected with appropriate vasoconstrictors and intravenous fluids to maintain mean arterial pressure within 20% of the patient's baseline.
  - Patients with pulmonary hypertension or congenital heart disease are less likely to tolerate wide physiological swings.

- Surgical Considerations
  - Continuous communication between the surgical and anesthesia teams is critical.
  - A tracheostomy tray should be available in the room at induction.
  - Ensure that the rigid bronchoscope is fully assembled and functional prior to induction.
  - The surgeon will require the use of a laryngoscope to place suspension devices
  - At times, the patient will be mask-ventilated by the surgeon. Monitor the adequacy of chest rise and airway patency
  - Ventilation may be achieved via the side port of the rigid bronchoscope (use a flexible connector to minimize torque)
  - Minimize the inspired oxygen fraction during laser treatment

- The surgeon may perform a leak test which involves the insertion of sequentially sized uncuffed endotracheal tubes with gradual increases in airway pressure to visually assess for leak (bubbling around the ETT)

- Emergence
    - In certain clinical scenarios, patients may require placement of an ETT to secure the airway prior to emergence.
    - Consider placing and removing an orogastric tube to empty the stomach.
    - A lateral oblique position will minimize airway obstruction and is safer if regurgitation occurs.
    - Monitor for signs of airway edema during recovery, such as stridor and/or a ‘barking’ cough.

- Postoperative Care/Disposition
    - Discussion with surgeon about appropriate postoperative monitoring location (high or low acuity) should occur prior to the procedure.

Case Specific Complications/Pitfalls

- In spontaneously breathing ‘tubeless’ techniques, there is a significant risk of laryngospasm
- If laryngospasm occurs, it will require interruption of surgery, mask ventilation with an oral airway and require a decision about appropriate drug management (Propofol vs. Succinylcholine)
- In recurrent respiratory papillomatosis, muscle relaxation is relatively contraindicated.
- In patients at risk of aspiration, consider the risks versus benefits of a ‘tubeless’ technique.
- Assess the risk of an airway fire during the ‘time-out’ prior to induction and take appropriate precautions (eye protection, laser-safe endotracheal tubes, moist sponges, $FiO_2 < 30\%$).
- Calculate the maximum allowable dose of lidocaine for airway topicalization.
- It is vital to discuss anesthesia and ventilation plans with the surgeon prior to induction.

References

1) Dalesio, N., Hayward, D., J., Schwengel, D. Anesthesia for Pediatric Otorhinolaryngologic Surgery. In *Smith's Anesthesia for Infants and Children* 9th ed. Philadelphia, PA; Elsevier. 2017: pp. 817-842
2) Litman, R., Fiadjoe, J., Stricker, P., Cote, CJ. *The Pediatric Airway. In A Practice of Anesthesia for Infants and Children* 5th ed. Philadelphia, PA; Elsevier: 2013: pp. 237-236
3) Bradley, J., Lee, G., Peyton, J. Anesthesia for Shared Airway Surgery in Children. Pediatric Anesthesia. 2020: 30(3): 288-295 PubMed Link

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