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CHAPTER 12.3

Pediatric Otolaryngology

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Myringotomy and Tympanostomy Tube Placement

Surgical Considerations

Description: Tympanostomy (PE or pressure equalizing) tubes are placed in the patient with chronic serous otitis media (fluid in the middle ear for > 3 mo) or recurrent acute otitis media (6 or more episodes of otitis media over the prior yr). Occasionally, PE tubes are placed in a child with meningitis of otitic origin or with acute otitis media that is unresponsive to antibiotics. The patient is supine and the OR table in the 0° position. The microscope is positioned over the bed and the head turned to expose the ear. An ear speculum is inserted into the ear canal, cerumen is removed, and an incision is made in the tympanic membrane. Fluid is sometimes suctioned from the middle ear; then, a tympanostomy tube is inserted into the ear, straddling the tympanic membrane. Antibiotic ear drops frequently are inserted into the external auditory canal. Sometimes lidocaine and/or oxymetazoline drops are also inserted into the ear canal. The surgeon moves to the other side of the table, the microscope is repositioned, the head is turned, and the procedure is repeated on the other ear.

Usual preop diagnosis: Chronic serous otitis media (CSOM); recurrent acute otitis media (RAOM)

Summary of Procedures

Position	Supine; head to anesthesia
Incision	Tympanic membrane
Special instrumentation	Operating microscope
Antibiotics	No parenteral antibiotics (except for SBE prophylaxis); topical antibiotic ear drops
Surgical time	5–10 min. Patients with stenotic ear canals (e.g., Down syndrome) can take longer.
EBL	None
Postop care	PACU → home
Mortality	Rare
Morbidity	Bleeding from ear Purulent drainage from ear (otorrhea)
Pain score	1–3

Patient Population Characteristics

Age range	3 mo+ (most common, 1–3 yr)
Male:Female	1:1
Incidence	Very common

Etiology	Chronic middle ear infections
Associated conditions	Cleft palate

Anesthetic Considerations

Preoperative

The majority of children presenting for PE tubes are < 3 yr and generally in good health. Many of these children, however, have recurrent URI, which contributes to edema of the eustachian tubes, predisposing to episodes of acute otitis media. Intervals between URI may be brief, and scheduling surgery during these interludes is often impractical. *(Print pagebreak 1181)* Children with mild URI generally can be anesthetized safely for PE tube placement, because tracheal intubation is generally not performed. Surgery should be delayed for patients with acute, febrile illnesses, and in those with Sx referable to the lower airways (e.g., productive cough, wheezing). Surgery need not be delayed if fever is 2° acute otitis media.

Respiratory	Surgery in patients with URI Sx referable to the extrathoracic airway alone is generally not delayed. These Sx include nasal congestion and/or discharge and mild conjunctivitis. Fever accompanied by productive cough and wheezing are Sx of lower respiratory tract involvement and should prompt rescheduling of the procedure 2–3 wk after these Sx have abated. In borderline cases (e.g., those with rales auscultated on chest exam but no other lower tract Sx), O_2sat may be measured by pulse oximetry. Procedures in patients with SpO_2< 95% should be deferred.
Laboratory	None
Premedication	Some practitioners advocate withholding premedication, as the duration of action of the premed may outlast the surgery. In general, however, we administer oral midazolam to patients > 9 mo (see p. D-1) and have not found a significant related delay in discharge from PACU. Parental presence in the OR may obviate the need for premedication in selected cases.

Intraoperative

Anesthetic technique: GA via face mask

Induction	A standard inhalation induction with sevoflurane and O_2± N_2O is performed with routine monitoring. An oral airway commonly is inserted, as soft tissue obstruction may occur when the head is turned fully to the side during surgery. CPAP 5–8 cmH_2O also may be useful in maintaining airway patency. Following induction, a one-time dose of rectal acetaminophen (30–40 mg/kg) may be given for postop analgesia. (↓ rectal dose if po acetaminophen is given at home or as premedication.)
Maintenance	Marked agitation (“emergence delirium”) has been noted following emergence from sevoflurane and other inhaled agents. A variety of strategies have been used to minimize this phenomenon, including nasal or IM fentanyl (1–2 mcg/kg) or ketamine. Since an iv catheter is not placed routinely, iv drugs are not usually given.
Emergence	For bilateral procedures, the potent inhaled anesthetic is D/C'd before or during the 2nd myringotomy to facilitate prompt emergence. N_2O is continued until the completion of surgery. As the patient is awakening, gentle oropharyngeal suctioning is performed.
Blood and fluid requirements	None
Monitoring	Standard monitors (see p. D-1).
Positioning	and pad pressure points. eyes.
	Secretions → laryngospasm 2° irritation of the vocal cords, especially in children with URI. Rx: 100% $O_2$and CPAP or manual

Complications	Laryngospasm	ventilation with PEEP ≥ 20–25 cm H_2O. Rarely, succinylcholine (2–4 mg/kg im) may be needed if a significant decrease in SpO_2 occurs and ventilation is not possible. Atropine (0.01–0.02 mg/kg) should be given in the same syringe to mitigate the bradycardia associated with succinylcholine. Oropharyngeal suctioning and manual ventilation usually result in resolution of the laryngospasm. Rarely, tracheal intubation may be indicated for recurrent laryngospasm.

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Postoperative

Complications	Laryngospasm	Laryngospasm may occur, and should be treated as described above.
Pain management	Acetaminophen 10–15 mg/kg po Ibuprofen 10 mg/kg Hydrocodone 0.15 mg/kg po	Consider previously administered po and/or pr dosing.

Suggested Readings

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Tonsillectomy and Adenoidectomy

Surgical Considerations

Description: The dissection is carried out with the patient supine, shoulders slightly elevated by a shoulder roll (typically, a rolled towel). A mouth gag is inserted, and a small suction catheter is passed through the nose and brought out the mouth to elevate the soft palate and expose the nasopharynx. The adenoids are viewed with a mirror and/or palpated. A curette, adenotome, microdebrider or suction electrocautery is used to remove the adenoids; then, typically, the nasopharynx is packed. There are two major types of tonsillectomy: total tonsillectomy and subtotal (partial) tonsillectomy. The traditional total tonsillectomy is performed by grasping the tonsil with Allis forceps and pulling it medially. A vertical incision is made in the anterior tonsillar pillar with a sickle knife, scissors, or electrocautery instruments; then, the tonsil is dissected from the surrounding tissue and removed. A snare may be used to amputate the inferior pole of the tonsil before removal. Hemostasis is obtained through use of packs and suction electrocautery. After hemostasis has been obtained in the tonsillar fossae, the pack is removed from the nasopharynx, and hemostasis is achieved in

the nasopharynx using suction electrocautery. Tonsils can also be completely removed using radiofrequency (Coblation), bipolar scissors, bipolar forceps or laser. The same approach and set-up is used for a subtotal tonsillectomy which can be performed using radiofrequency or a microdebrider. The literature on incisional local anesthetic injection is mixed with some studies reporting benefit and some showing no benefit. Therefore, injection is not generally recommended.

Usual preop diagnosis: Obstructive sleep apnea (OSA); chronic tonsillitis and/or adenoiditis; tonsillar and adenoid hypertrophy; asymmetric enlargement of tonsils (to r/o cancer)

Summary of Procedures

Position	Supine, shoulder roll, head extended; table turned 90°; surgeon at head of table
Incision	Intraoral mucosal
Special instrumentation	Mouth gag (McIvor, Crowe-Davis, Dingman)
Unique considerations	Observe for compression of ETT or accidental extubation when mouth gag is manipulated. Patients with Down syndrome may need to be evaluated preop for possible atlantoaxial subluxation, as the neck is typically extended. Steroids (e.g., dexamethasone 0.5 mg/kg) used routinely by some practitioners.
Antibiotics	Not used routinely.
Surgical time	30 min
EBL	10–200 mL. Monitor closely.
Postop care	Lateral position; suction in midline only. Most commonly, PACU → home. Overnight stay, if < 2 yr or other comorbidities.
Mortality	Rare
Morbidity	Bleeding: 2–3% Aspiration: Rare Tooth damage: Rare
Pain score	Adenoidectomy, 3–5; tonsillectomy, 6–9

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Patient Population Characteristics

Age range	1 yr+ (most common, 2–8 yr)
Male:Female	1:1
Incidence	300,000 cases/yr in the United States
Etiology	OSA; chronic infection; peritonsillar abscess; snoring. (R/O lymphoma, carcinoma, lympho-proliferative disease.)
Associated conditions	Down syndrome

Anesthetic Considerations

Preoperative

While most children presenting for tonsillectomy and/or adenoidectomy are healthy, a variety of medical problems may coexist. Severe adenoidal hyperplasia may cause nasopharyngeal obstruction, obligate mouth breathing, failure to thrive 2° poor feeding, and disturbances of speech and sleep. Chronic nasal obstruction may result in narrowing of the upper airway and dental and facial changes (so-called adenoidal facies). Tonsillar hyperplasia may cause airway obstruction, OSA, CO_2 retention, cor pulmonale, and failure to thrive. Most of these changes are reversible with removal of the adenoids and tonsils. Children presenting f or

adenoidectomy/tonsillectomy also frequently have URI (see Anesthetic Considerations for Myringotomy and Tympanostomy Tube Placement p. 1181).

Respiratory	See discussion under Anesthetic Considerations for Myringotomy and Tympanostomy Tube Placement (see p. 1181).
Dental	Examination of the airway should include inspection of the teeth. Parents should be advised that loose teeth may be dislodged during placement of the mouth gag or laryngoscopy.
Cardiovascular	In children with severe OSA, CXR and EKG should be done to evaluate the presence of cor pulmonale. If significant RVH and/or cardiomegaly are present, consider ECHO and consultation by pediatric cardiologist.
Hematologic	A careful Hx is taken for Sx of easy bruising or bleeding. If present, a CBC with Plt count, as well as PT, INR, PTT, and bleeding time are performed. In patients with a negative Hx, we order no preop lab tests.
Premedication	Children with severe OSA (airway obstruction) who are very anxious may receive a reduced dose of oral midazolam (see p. D-1) in a well-monitored environment (e.g., with an experienced RN or member of the anesthesia team present). SpO_2 should be monitored following administration of premedication.

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Intraoperative

Anesthetic technique: GETA

Induction	Standard inhalation induction (see p. D-1); airway obstruction during induction is common in these patients, and usually is alleviated with placement of an oral airway and administration of CPAP: 10–20 cm H_2O. An iv catheter should be placed as soon as possible to facilitate administration of muscle relaxant if needed with glycopyrrolate (4–6 mcg/kg) to reduce oral secretions. Some practitioners prefer not to paralyze these patients due to the brevity of the procedure; propofol may be given before laryngoscopy. For patients with severe OSA, consider iv induction to facilitate prompt placement of the ETT. An oral RAE ETT is used and taped securely in the midline position to facilitate placement of the mouth gag. A cuffed ETT may be desirable because, in combination with a throat pack, it minimizes the risk of entry of blood and oral secretions into the trachea during surgery. Care should be exercised in ensuring that the inferior part of the oral RAE tube is long enough for the cuff to pass beyond the vocal cords. A short tube may easily dislodge with changes in head position, or the cuff may cause vocal cord trauma. Bilateral breath sounds and chest excursion should be confirmed after placement of the mouth gag, which may cause kinking and obstruction of the ETT. Acetaminophen (30–40 mg/kg) may be given pr after induction. (↓ dose if po acetaminophen given with premedications.)
Maintenance	Standard maintenance (see p. D-2). An intermediate-acting NMR (e.g., rocuronium 0.6–1.0 mg/kg or vecuronium 0.1 mg/kg) may given to facilitate tracheal intubation. Opioids (e.g., fentanyl 2–3 mcg/kg, morphine sulfate 0.1–0.15 mg/kg) are given for postop analgesia. The use of propofol, ± remifentanil, instead of anesthetic vapor, may ↓ the incidence of PONV, which is common following tonsillectomy/adenoidectomy. Administration of ondansetron (0.1 mg/kg, up to 4 mg) is controversial due to some evidence that it can mask postop bleeding, with retained blood in the stomach. Dexamethasone 0.25–1.0 mg/kg may be given to reduce airway edema and PONV.
Emergence	Blood and secretions should be suctioned from the oropharynx and stomach following the completion of surgery. The patient should be fully awake before tracheal extubation, which may be performed supine or in the lateral position with the head down. Verify removal of throat packs. Alternatively, extubating under deep anesthesia decreases

	coughing, but requires vigilance to avoid airway obstruction and aspiration at emergence and during transport to PACU.	
Blood and fluid requirements	IV: 22 or 20 ga × 1 NS/LR @ 5–10 mL/h	Blood loss is typically 4 mL/kg and may accumulate in the stomach → N/V (unless prevented by antiemetics).
Monitoring	Standard monitors (see p. D-1).	
Positioning	and pad pressure points. eyes.	
Complications	Airway obstruction ETT dislodgement/kinking	Usually caused by insertion/manipulation of mouth gag.

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Postoperative

Complications	Airway obstruction	Retention of throat pack → airway obstruction. Remove with Magill forceps. Recurrent airway obstruction may require application of positive pressure via face mask (CPAP vs manual ventilation with PEEP) ± placement of an oral airway. Severe postop airway obstruction is more common in patients < 2 yr. In these patients, admission to PICU may be necessary. CPAP via face mask or nasal mask may be helpful. On rare occasions, tracheal intubation and mechanical ventilation are required until swelling of the airway resolves.
	Hemorrhage	Bleeding may occur in the immediate postop period or several d later. Patients present with anemia and hypovolemia, as well as airway compromise and a full stomach 2° swallowed blood. IV fluids, including blood, should be given before induction. Rapid-sequence intubation (see p. B-4) should be performed with cricoid pressure in preparation for surgical treatment.
Pain management	Morphine 0.025–0.05 mg/kg	May be given incrementally in PACU. Subsequently, acetaminophen with or without hydrocodone 0.15 mg/kg is given. Local anesthetic injection by the surgeon into the tonsillar and adenoidal beds ↓ postop opioid requirements.

Suggested Readings

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Bronchoscopy/Esophagoscopy

Surgical Considerations

Description: Flexible bronchoscopy is performed when the dynamics of the larynx and trachea need to be visualized. The child is supine on the OR table, which is turned 90–180°. With the child sedated or under GA, but breathing spontaneously, the bronchoscope is passed through the nose into the pharynx by way of an adapter attached to a standard anesthesia mask. Alternatively, the bronchoscope can be passed through an LMA if visualization of the pharynx is not required. The larynx is viewed with the patient breathing spontaneously so that vocal cord movement can be observed; then the anesthesia is deepened and the bronchoscope passed into the trachea. The trachea and bronchi are viewed and, when indicated, bronchoalveolar lavage or bronchial biopsy can be performed.

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Rigid bronchoscopy is preferred when direct ventilation of the trachea is required and/or when foreign bodies (FBs) need to be removed. It also can be used for Dx of airway lesions. Direct laryngoscopy is performed and topical anesthetic is applied to the larynx and trachea. The rigid bronchoscope is passed through the vocal cords into the trachea. The anesthesia tubing is connected to the bronchoscope and the patient is ventilated through the scope. If a FB is present, the telescope within the bronchoscope will be removed and optical forceps inserted through the bronchoscope to remove the FB. During the time when the telescope is being changed, a leak will be present in the ventilation system.

Usual preop diagnosis: Airway obstruction; stridor; bronchial FB; pneumonia (requiring bronchoalveolar lavage); tracheal or bronchial lesion

Flexible or rigid esophagoscopy can be performed for diagnostic or therapeutic (removal of FB) purposes. Flexible esophagoscopy can be performed under sedation; however, GETA is preferred for rigid esophagoscopy. The esophagoscope is inserted through the mouth into the esophagus, and the entire length of the esophagus is viewed. If a FB is to be removed with the rigid esophagoscope, the telescope and forceps are passed through the lumen of the esophagoscope. If a FB (especially food stuff) is to be removed with the flexible esophagoscope, the scope may need to be passed several times.

Esophageal dilation may be performed in one of several ways. Balloon dilation can be performed with the flexible esophagoscope. Alternatively, a guide wire can be passed through the esophagoscope, then Savary/Gilliard dilators, in successively larger sizes, are passed over the wire. Another option is to remove the esophagoscope after the stenosis has been visualized; then, Maloney or Hurst dilators are passed blindly through the mouth and into the esophagus. Care must be taken to avoid accidental extubation of the patient while the dilators are being inserted and removed.

Usual preop diagnosis: GERD; esophageal FB; esophageal stricture

Summary of Procedures

	Bronchoscopy	Esophagoscopy
Position	Patient supine; table turned 90°	

Unique considerations	Ventilate through rigid bronchoscope. Ventilate via mask with adapter for flexible bronchoscope or via LMA. Dexamethasone (0.5 mg/kg) may be indicated, if glottic or subglottic edema is present.	Observe for accidental extubation. ETT taped to left side of mouth.
Antibiotics	None	
Surgical time	10 min–1.5 h	15 min–1 h
EBL	None	< 10 mL
Postop care	Watch for airway compromise; PACU.	PACU
Mortality	Rare	
Morbidity	Laryngospasm Laryngeal edema Dental trauma	Esophageal perforation Bleeding
Pain score	3–4	3–4

Patient Population Characteristics

Age range	Newborn+
Male:Female	1:1
Incidence	Common
Associated conditions	Bronchoscopy requiring bronchial alveolar lavage (BAL): immunocompromised patient Esophageal stricture: tracheoesophageal fistula (TEF) Esophageal FB: esophageal stricture

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Anesthetic Considerations

See Anesthetic Considerations following Laryngoscopy, Supraglottoplasty, Excision of Laryngeal Lesions, p. 1188.

Laryngoscopy, Supraglottoplasty, Excision of Laryngeal Lesions

Surgical Considerations

Description: Flexible laryngoscopy typically is performed in the clinic setting, but may be performed in the OR in an unstable or uncooperative child. The patient should be breathing spontaneously, and will be in a sitting (with support) or supine position. Topical anesthesia and vasoconstrictors are applied to the nose; then the scope is passed through the nose into the pharynx, and the larynx is viewed. Vocal cord function is best assessed with the child only mildly sedated.

Diagnostic direct laryngoscopy is performed with the child in a supine position, table turned 90°, with a small shoulder roll in place. The laryngoscope is introduced and, with a lifting motion, a thorough exam of the oropharynx, hypopharynx, and larynx is performed. If more than a brief exam is to take place, the vocal cords are anesthetized with topical lidocaine to help prevent laryngospasm. A telescope (often connected via camera to a video monitor), or bronchoscope, may be passed through the vocal cords to observe the trachea and major bronchi.

Microlaryngoscopy with removal/ablation of laryngeal lesions—most commonly papillomas, nodules, or polyps—is accomplished by suspending the laryngoscope from the Mayo stand or OR table, using a suspension apparatus. The patient continues to breathe spontaneously or is paralyzed and jet-ventilated. Papillomas may be removed with a cup forceps, microdebrider, or laser. When the laser is used, the patient's eyes and face are covered with a damp cloth. OR personnel must wear protective glasses. A microscope with the laser attached is positioned so that the laser beam passes through the laryngoscope onto the vocal folds. Alternatively, the laser may be held by the surgeon and passed through an optical fiber.

Young infants with severe laryngomalacia may undergo a **supraglottoplasty** for relief of airway obstruction. The laryngoscope is suspended and the laser or microlaryngeal instruments are used to remove redundant aryepiglottic fold tissue.

Usual preop diagnosis: Diagnostic laryngoscopy: hoarseness; airway obstruction; stridor. Operative laryngoscopy: laryngeal papillomas; laryngeal nodules; laryngeal web; laryngeal polyps; subglottic hemangioma or cysts; severe laryngomalacia

Summary of Procedures

Position	Supine; table turned 90°; shoulder roll
Special instrumentation	± Jet ventilation; laryngoscope suspension apparatus; video equipment; operating microscope
Unique considerations	Potential laser precautions; patient usually not intubated; dexamethasone 0.5–1.0 mg/kg to prevent laryngeal edema; laryngeal topical lidocaine 0.4 mg/kg.
Antibiotics	None
Surgical time	15–90 min
EBL	< 5 mL
Postop care	Observe for airway obstruction in PACU.
Mortality	Rare
Morbidity	Laryngospasm Laryngeal edema Dental trauma
Pain score	3–5

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Patient Population Characteristics

Age range	Newborn +
Male:Female	1:1
Incidence	Occasional
Etiology	Papillomas: Most commonly, viral infection contracted from mother during vaginal delivery Nodules, polyps: Vocal abuse, gastropharyngeal reflux Subglottic hemangioma: Unknown Subglottic cyst: Prior intubation Laryngeal cysts, webs: Congenital malformation Laryngomalacia: Unknown
Associated conditions	Chronic hoarseness, stridor; GERD; FTT

Anesthetic Considerations

(Procedures covered: bronchoscopy; esophagoscopy; laryngoscopy; supraglottoplasty; excision of laryngeal lesions)

Preoperative

Direct laryngoscopy (DL) is performed most commonly for patients with stridor. In infants, stridor is most often 2° laryngomalacia, with vocal cord paralysis and obstructive airway lesions being less common. Patients with severe laryngomalacia and those with post-transplant lymphoproliferative disease involving the epiglottis may undergo supraglottoplasty. Older children may present with stridor 2° laryngeal masses or papillomatosis, for which laser excision may be performed. A careful H&P is contributory to Dx, after which flexible laryngoscopy in the ENT clinic can be confirmatory.

Laryngoscopy and **rigid bronchoscopy** also are performed for the removal of airway foreign bodies (FBs). A Hx of choking and/or coughing while eating is usually elicited. Children may present with agitation, wheezing, and cyanosis. This condition constitutes a true surgical emergency and the patient should be taken to the OR as soon as possible.

Airway/Respiratory	Stridor usually is worsened with crying or agitation, and often is less severe during sleep.
Dental	Any loose teeth may be dislodged.
Laboratory	No routine tests indicated. In stable patients with suspected FB aspiration, CXR may be obtained.
Premedication	Because stridor often is decreased during quiet breathing and sleep, premedication with oral midazolam is usually beneficial in patients > 9 mo. Children with FB aspiration generally should not be given po medications. They may benefit from small doses of iv midazolam. EMLA or ELA-max® cream may be applied 45 or 20 min (respectively) in advance to iv sites for topical anesthesia.

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Intraoperative

Anesthetic technique: GA. Primary and backup plans for airway management during the procedure should be discussed in detail with the ENT surgeon in advance of anesthetic induction.

Induction	Mask induction is followed by placement of an iv catheter, if not already in place. In cases where vocal cord function must be evaluated, spontaneous breathing is maintained under sevoflurane in 100% O_2 Alternatively, propofol (2–3 mg/kg) ± ketamine (1–2 mg/kg) may be used for induction followed by a continuous infusion (see below).
Maintenance	Before removal of the face mask for DL, a deep level of anesthesia is achieved. During DL, blow-by $O_2$is administered. For patients in whom vocal cord function must be assessed a gradual reduction of inhalational anesthesia or an iv anesthetic infusion should →↑ vocal cord excursion. Supraglottoplasty and laser excision of laryngeal lesions may be performed with intermittent mask anesthesia. Propofol ± remifentanil or ketamine may be used, thereby avoiding contamination of the OR with inhaled anesthetics while providing continuous anesthesia. In general, the trachea is not intubated, as even a small ETT will interfere with the surgical procedure. For patients who are paralyzed or hypoventilating, jet ventilation may be maintained using a Sanders jet ventilator (see Fig 3-4, p. 199). Intermittent jets of 100% $O_2$are delivered with a high-pressure (40–55 psi) gas source through a tube incorporated into the laryngoscope blade. As the jet is pointed toward the glottic opening, gas is entrained by the Venturi effect. Manual jet ventilation is performed while chest excursion is observed to ensure that excessive inflating pressures and volumes are avoided. During jet ventilation, anesthesia is maintained with iv agents. Propofol is infused with remifentanil or ketamine. (Remifentanil 0.1 mg may be added to each 10 mL of propofol in a single syringe; e.g., for a propofol infusion of 100 mcg/kg/min, remifentanil 0.1 mcg/kg/min is delivered. Ketamine 1–3 mg/mL of propofol may be added as an alternative to remifentanil). **NB:** fire hazard during laser surgery is minimal in the absence of a combustible material (e.g., plastic) in the field. An $FiO_2$of 1.0 may, therefore, be used safely, unless a plastic ETT is in place. For selected laser procedures involving the tissues around the glottis, a metal or metal-wrapped ETT may be used. When a plastic ETT is in place, the lowest possible $FiO_2$is used (O_2/air mixture) to maintain an acceptable SpO_2 During rigid bronchoscopy, ventilation is performed through a side port of the bronchoscope. Assisted, spontaneous ventilation under deep inhalational anesthesia may be maintained. Alternatively, iv anesthesia with or without muscle relaxation may be preferred, as described above. For FB cases, maintenance of spontaneous ventilation generally is preferred to avoid distal displacement of the FB. Gentle, assisted ventilation may be required, however, to ensure adequate oxygenation and ventilation. A conventional ETT sometimes is placed after removal of the laryngoscope or

Emergence	bronchoscope, as laryngospasm following these procedures is common. Tracheal extubation is performed with the patient fully awake and following complete reversal of neuromuscular blockade, if applicable.	
Blood and fluid requirements	IV: 22 ga × 1 NS/LR @ 3–5 mL/kg/h	Blood loss is minimal.
Monitoring	Standard monitors (see p. D-1).	
Positioning	Table rotated 90° and pad pressure points.	Shoulder roll/neck extension for surgery
	eyes.	Eyes covered with wet sponges or goggles when laser in use.
Complications	Hypoventilation Hypoxemia	Adjust Sanders jet; mask ventilation prn.
	Airway injury Pneumothorax	2° jet ventilation, DL/bronchoscope
	Laryngospasm	Rx: 100% O_2 CPAP vs manual ventilation/PEEP
	Eye injury	
	Airway fire	Remove ETT; irrigate with NS; resume ventilation with 100% $O_2$when fire extinguished.

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Postoperative

Complications	Dental trauma Bleeding Eye trauma Pneumothorax	
Pain management	Acetaminophen (10–15 mg/kg) po q 6 h ± Hydrocodone 0.15 mg/kg or codeine 1 mg/kg q 4 h	
Tests	CXR	If respiratory distress or ↓ SpO_2present.

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Removal of Branchial Cleft Cyst or Thyroglossal Duct Cyst

Surgical Considerations

Description: Branchial cleft cysts and tracts typically present in the lateral neck; thyroglossal duct cysts, in the midline. Removal consists of making an incision in the neck around the opening of the tract (if present), or over the palpable cyst, and following the tract superiorly to its origin. A **Sistrunk procedure** is performed in the case of a thyroglossal duct cyst, and involves the removal of the middle section of the hyoid bone.

Usual preop diagnosis: Branchial cleft cyst; thyroglossal duct cyst

(Print pagebreak 1191)

Summary of Procedures

Position	Supine; head 180° from anesthesia; oral intubation
Incision	Horizontal neck
Antibiotics	Clindamycin 12 mg/kg or cefazolin 25 mg/kg
Surgical time	45–90 min
EBL	10–50 mL
Postop care	Routine
Mortality	Rare
Morbidity	Bleeding/neck hematoma Infection Recurrence of cyst Damage to CN XI, XII
Pain score	4–6

Patient Population Characteristics

Age range	Newborn–adult
Male:Female	1:1
Etiology	Congenital
Associated conditions	Branchio-oto-renal (BOR) syndrome

Anesthetic Considerations

See Anesthetic Considerations following Incision/Drainage of Deep Neck Abscess (p. 1192).

Incision/Drainage of Deep Neck Abscess

Surgical Considerations

Description: Children with deep neck abscesses (retropharyngeal, parapharyngeal, peritonsillar) are at risk for acute airway obstruction; therefore, the abscesses are drained on an emergent basis. Retropharyngeal and peritonsillar abscesses typically are drained through an intraoral approach; parapharyngeal abscesses, through an external neck approach. In each case, the child must be intubated orally and placed in the supine position. The anesthesiologist or otolaryngologist who is intubating the child must be

prepared for abnormal pharyngeal anatomy 2° the abscess. Care must be taken that the abscess is not ruptured in the intubation process. In most cases, the child can be extubated immediately after the abscess is drained; however, in a small number of cases, the child may need to remain intubated until the pharyngeal edema subsides.

Usual preop diagnosis: Retropharyngeal, parapharyngeal, or peritonsillar abscess

Summary of Procedures

Position	Supine; table turned 90–180°; oral intubation
Incision	Intraoral (retropharyngeal or peritonsillar abscess); lateral neck (parapharyngeal abscess)
Unique considerations	Acute airway obstruction can occur with induction. Care must be taken to avoid rupture of abscess on intubation; ± dexamethasone 0.5 mg/kg.
Antibiotics	Clindamycin 10 mg/kg
Surgical time	30–90 min
EBL	< 30 mL
Postop care	May remain intubated postop.
Mortality	Rare
Morbidity	Aspiration (if abscess ruptures spontaneously) Airway obstruction 2° aspiration or edema Bleeding
Pain score	5

(Print pagebreak 1192)

Patient Population Characteristics

Age range	Most common, 6 mo–3 yr; can occur at any age.
Male:Female	1:1
Incidence	Uncommon
Etiology	URI

Anesthetic Considerations

(Procedures covered: excision of branchial cleft and thyroglossal duct cyst; incision/drainage of neck abscess)

Preoperative

These patients generally are otherwise healthy children. A cystic hygroma (cystic lymphangioma), as with other neck masses, may cause airway obstruction and difficult intubation.

Respiratory	The size and extent of the neck mass should be defined carefully in an effort to detect the potential for airway compromise and to avoid soft-tissue trauma during intubation, with consequent acute airway obstruction. Inspiratory stridor suggests supraglottic obstruction, while expiratory stridor is associated with subglottic/intrathoracic obstruction. These patients should have had prior CT/MRI imaging; scans and anesthesia records for these studies should be reviewed. **Tests:** CXR; CT/MRI

Cardiovascular	Cervical masses may be adherent to and/or cause compression of the great vessels. **Tests:** CT/MRI
Hematologic	T&C for cystic hygroma, or if a cervical mass involves great vessels or extends into the mediastinum. **Tests:** Hct
Laboratory	Other tests as indicated from H&P.
Premedication	If > 9–12 mo and asymptomatic, midazolam (0.5–0.75 mg po) 30 min prior to arrival in OR. Avoid all premedication in patients with significant potential for airway compromise.

(Print pagebreak 1193)

Intraoperative

Anesthetic technique: GETA

Induction	Standard pediatric induction (see p. D-1) in patients without airway compromise. When airway obstruction is present, iv should be secured prior to mask induction, which may be done with sevoflurane in 100% O_2 As the plane of anesthesia deepens, gently assist ventilation. Give atropine (0.01–0.02 mg/kg iv) prior to laryngoscopy. If partial airway obstruction exists, maintain spontaneous ventilation with CPAP and perform laryngoscopy at 3 MAC of volatile agent. FOB should be available. Have full range of ETT sizes available, since airway narrowing may be present. Once airway is secured, proceed with neuromuscular blockade (e.g., rocuronium 0.6–1.0 mg/kg or vecuronium 0.1 mg/kg).	
Maintenance	Standard pediatric maintenance (see p. D-2). Surgeon may infiltrate incision with local anesthetic. Limit lidocaine to 5 mg/kg when used without epinephrine, or 7 mg/kg when used with epinephrine, and bupivacaine to 2.5 mg/kg.	
Emergence	Reverse neuromuscular blockade with neostigmine (0.07 mg/kg iv) and atropine (0.02 mg/kg iv). Extubate when fully awake.	
Blood and fluid requirements	Minimal blood loss usually IV: 20–22 ga × 1 Great vessel involvement: IV: 20 ga × 1–2 NS/LR @ 3 mL/kg/h	Minimal 3rd-space losses. Each mL blood loss can be replaced with 3 mL NS/LR. When great vessels involved, place at least 1 iv in lower extremity. Blood loss can be quite sudden; have blood available in OR.
Monitoring	Standard monitors (see p. D-1). ± Arterial line, 22 ga	An arterial line is used when there is risk of large blood loss or periop airway compromise.
Positioning	and pad pressure points. eyes.	
Complications	ETT dislodged/loss of airway Laryngospasm Bronchospasm Hemorrhage	ETT must be secured carefully. Liberal use of benzoin adherent. Avoid tension on ETT by circuit hoses. Hold ETT during surgeon's intraoral examination to prevent accidental extubation.

Postoperative

Complications	Subglottic edema Upper airway obstruction from Edema related to tumor resection Recurrent laryngeal nerve injury	Dexamethasone (0.5–1 mg/kg iv) and nebulized racemic epinephrine (1.25%) with mist $O_2$to treat subglottic edema.
Pain management	Morphine (0.025–0.1 mg/kg iv q 2–4 h) Acetaminophen (10–15 mg/kg po/pr q 6 h)	The majority of these procedures are performed on outpatient basis (except cystic hygroma).

Suggested Readings

1. Gregory GA, ed: *Pediatric Anesthesia,* 4th edition. Churchill Livingstone, New York: 2002.

2. Motoyama EK, Davis PC, eds: *Smith's Anesthesia for Infants and Children,* 5th edition. CV Mosby, St. Louis: 1990.

3. Tapper D: Head and neck-sinuses and masses. In *Pediatric Surgery.* Ashcraft KW, Holder TM, eds. WB Saunders, Philadelphia: 1993, 923–34.

(Print pagebreak 1194)

Laryngotracheal Reconstruction, Cricotracheal Resection, Laryngotracheoplasty

Surgical Considerations

Description: A **laryngotracheal reconstruction** (LTR, laryngotracheoplasty) or **cricotracheal resection** (CTR) is performed in the patient with moderate-to-severe subglottic stenosis. Typically, the procedure starts with a diagnostic bronchoscopy. In most of these patients, a tracheotomy will already be present. During the procedure, the tracheotomy tube may be switched for an anode tube, which is sutured or taped to the chest. A horizontal neck incision is made over the cricoid cartilage. The strap muscles are separated in the midline, and the laryngeal cartilage and trachea are exposed. In a LTR a vertical incision (laryngofissure) is made through the inferior portion of the thyroid cartilage, through the cricoid cartilage, and down to the tracheotomy site. Either before or after the airway is exposed, costal cartilage, auricular cartilage, or thyroid cartilage will be harvested for use as a graft. The cartilage graft is then sutured into the anterior airway, keeping the laryngofissure incision open. Sometimes, a posterior cartilage graft is necessary in a severely stenotic airway, and this is placed after making an incision through the posterior cricoid. The initial exposure for a CTR is the same as a LTR but instead of placing a cartilage graft(s), the anterior portion of the cricoid cartilage and stenotic portion of the trachea are removed and the trachea pulled superiorly and sutured to the thyroid and remaining cricoid cartilages.

In a single-stage procedure, the ETT is removed intraop before the anterior cartilaginous incisions are closed, and replaced with an oral or nasal ET tube. This ETT is kept in place for 2–7 d as a stent around which the airway heals. In a two-stage procedure, the tracheotomy tube is kept in place. In this circumstance, there may be a stent superior to the tracheotomy tube, or a T-shaped tracheotomy tube may be used.

A **cricoid split** is most commonly performed in the NICU baby who fails extubation due to subglottic stenosis. Diagnostic bronchoscopy is performed; then the baby is reintubated or the bronchoscope is left in the airway and the procedure is performed over the bronchoscope. A laryngofissure is performed but no cartilage graft placed. Typically, an ETT 1/2 size larger than the previously placed ETT is inserted.

Usual preop diagnosis: Subglottic stenosis, subglottic hemangioma

Summary of Procedures

Position	Supine, shoulder roll
Incision	Horizontal neck
Unique considerations	After the cut is made into the airway, a leak may be present, depending on position of the cuff (if present).
Antibiotics	Clindamycin 10 mg/kg
Surgical time	Laryngotracheal reconstruction (LTR, laryngotracheoplasty), Cricotracheal reconstruction 1.5–4 hours Cricoid split: 45 min
EBL	5–30 mL
Mortality	Rare

Morbidity	Pneumothorax Bleeding Infection Stent or ETT dislodgement Residual/recurrent subglottic stenosis
Pain score	4–6; 6–8 if costal cartilage harvested.

(Print pagebreak 1195)

Patient Population Characteristics

Age range	Newborn–adult
Male:Female	1:1
Incidence	Rare
Etiology	ETT intubation; congenital
Associated conditions	Prematurity with prolonged NICU course

Anesthetic Considerations

Preoperative

These procedures are performed in patients with subglottic stenosis with a lesion that is either congenital or acquired. Congenital subglottic stenosis varies with regard to the length of trachea involved and the degree of stenosis. Segmental stenosis may occur in the region of the cricoid cartilage, midtrachea, or just above the carina. Sx are severe retractions, especially with agitation or intercurrent URI, dyspnea, and stridor. If the stenotic segment is short and severe, excision with primary anastomosis may be performed. If the involved segment is long, tracheoplasty is usually performed.

Acquired subglottic stenosis occurs as a complication of prolonged tracheal intubation and mechanical ventilation, most commonly in premature neonates with severe lung disease (infant respiratory distress syndrome [IRDS]). The stenotic lesion usually is limited to the level of the cricoid cartilage, and is treated with the cricoid split procedure. In addition to tracheal stenosis, tracheomalacia may be present.

Respiratory	Patients may be intubated and mechanically ventilated in the PICU. A variable degree of lung disease may be present; some patients may be on minimal ventilatory support, while others may require relatively high F_IO_2 and/or inflating pressures. Some patients will have an indwelling tracheostomy tube that bypasses the stenotic lesion, and may be cared for at home. **Tests:** As indicated from H&P.
Cardiovascular	Although not common, cor pulmonale with RVH may be present 2° chronic lung disease.
Hematologic	Anemia is common, especially in infants with chronic lung disease. **Tests:** Hct
Premedication	Infants in PICU usually are receiving a regimen of sedative and analgesia drugs. These should be continued until the patient is transported to the OR, with supplemental doses given preop as needed. Tolerance may be present, and drug doses should be titrated to achieve an adequate level of sedation.

Intraoperative

Anesthetic technique: GETA

Induction	In intubated or trached patients with iv access, an iv induction is performed; otherwise, a mask induction is done with inhalation agents. Care should be taken to preserve upper airway patency, as even mild obstruction tends to exacerbate tracheal collapse. Following induction, tracheal intubation is performed with an ETT smaller than normal for age. In patients with severe stenosis, an ETT as small as 2.5 mm may be required. A cuffed tube is recommended and the surgeon should be careful not to damage the cuff during the procedure. If prolonged sedation and mechanical ventilation are planned postop, central venous access should be considered.	
Maintenance	Plans for postop mechanical ventilation are discussed with the surgeon. In those patients for whom mechanical ventilation is planned for > 24 h, high-dose opioid anesthesia is appropriate (e.g., fentanyl 20–50 mcg/kg), as well as a long-acting muscle relaxant (pancuronium). A mixture of air and O_2 is used to minimize the risk of airway fire.	
Emergence	The majority of patients are transported to the PICU with indwelling ETT and residual sedation, narcosis, and neuromuscular blockade. These patients should be transported with iv sedation (propofol, benzodiazepine, or dexmedetomidine). Emergent reintubation poses a higher risk in these patients should an accidental extubation occur.	
Blood and fluid requirements	IV: 24 or 22 ga × 1 NS/LR @ maintenance	Blood loss < 30 mL
Monitoring	Standard monitors (see p. D-1).	
Positioning	and pad pressure points. eyes.	
Complications	Tracheal edema Injury to neck structures: Trachea Vascular structures Recurrent laryngeal nerve injury	Rx: dexamethasone (0.5–1 mg/kg)

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Postoperative

Complications	Tracheal disruption (leak) Recurrent laryngeal nerve injury	Presents with subcutaneous emphysema of the neck, face and chest wall. May cause vocal cord dysfunction.
Sedation/analgesia	Heavy sedation	To minimize head and neck movement and tracheal wound disruption while ETT is in place.

Suggested Readings

1. Allen TH, Stevens IM: Prolonged endotracheal intubation in infants and children. *Br J Anaesth* 1985; 37:566–73.

2. Cotton RT: Pediatric laryngotracheal stenosis. *J Pediatr Surg* 1984; 19:699.

3. Vinograd I, Klim B, Efrati Y: Airway obstruction in neonates and children: surgical treatment. *J Cardiovasc Surg* 1994; 35: 7–12.

Choanal Atresia Repair

Surgical Considerations

Description: Infants born with bilateral choanal atresia typically have severe airway distress shortly following birth, because neonates are obligate nose breathers. The distress resolves after the child is intubated or a McGovern nipple (large nipple with cross-cuts in the end) or oral airway is positioned in the oral cavity. These infants undergo primary repair of the atresia within the first few

days of life. Children with unilateral choanal atresia usually do not have severe respiratory distress and, thus, surgery is often postponed until a later age.

Intranasal repair involves opening up the atretic area with choanal dilators, urethral sounds, a microdebrider or drill. Endoscopic sinus instruments are used to view the choanae and remove the posterior nasal septum. Sometimes an intranasal stent is placed. If a transpalatal repair is performed, a Dingman mouth gag is placed in the mouth, a *(Print pagebreak 1197)* palatal flap is raised and the posterior portion of the hard palate and posterior septum is removed. A stent is positioned in the nose. The infant should be able to breathe spontaneously through the nose at completion of either procedure.

Usual preop diagnosis: Bilateral or unilateral choanal atresia

Summary of Procedures

Position	Supine; rotate bed 90–180°
Incision	Intranasal or intraoral
Special instrumentation	Choanal dilators; Dingman mouth gag
Antibiotics	Clindamycin 10 mg/kg
Surgical time	30 min–2 h
EBL	< 10 mL
Postop care	Observation in PICU for respiratory distress
Mortality	Rare
Morbidity	Bleeding Pressure necrosis to nasal ala from stent Infection Airway obstruction if stents become malpositioned
Pain score	3–6

Patient Population Characteristics

Age range	Newborn–young child
Male:Female	1:1
Incidence	Rare
Etiology	Congenital
Associated conditions	Coloboma, heart disease, atresia choanae, retarded growth, genital anomalies, and ear deformities (CHARGE) association (see Anesthetic Considerations, below).

Anesthetic Considerations

Preoperative

Because many neonates are nasal breathers, choanal atresia may present with cyanosis at rest, resolving with crying or placement of an oral airway. Unilateral atresia is usually asymptomatic; bilateral lesions usually → respiratory distress in the neonatal period, but occasionally are asymptomatic. Although choanal atresia is most commonly an isolated anomaly, it may present as part of the CHARGE association.

Respiratory	Classic findings include cyanosis at rest, resolving with crying.
Cardiovascular	When part of the CHARGE association, cardiac defects include tetralogy of Fallot, ASD, VSD, PDA, AV canal, or right-side aortic arch.

Neurologic	When part of the CHARGE association, a variety of CNS abnormalities may be present. Hypoxia 2° airway obstruction may cause CNS impairment and Sz.
Premedication	Repair of choanal atresia usually is performed in infancy, and premedication is not indicated.

(Print pagebreak 1198)

Intraoperative

Anesthetic technique: GETA

Induction	Standard pediatric induction (see p. D-1). Airway obstruction may develop during induction of anesthesia. Early placement of an oral airway is recommended to relieve airway obstruction. An oral RAE ETT is preferred, especially if a transpalatal repair is planned using a Dingman mouth retractor.	
Maintenance	Inhalational or iv anesthesia is maintained during the procedure. During the first mo of life, opioids (other than remifentanil) should be avoided generally because of the risk of postop respiratory depression. For infants undergoing repair after the first mo of life, small doses of fentanyl (1–2 mcg/kg) or morphine sulfate (0.05–0.1 mg/kg) may be given. Muscle relaxation does not need to be maintained following tracheal intubation.	
Emergence	Nasal stents placed following the repair must be secure and free of secretions prior to tracheal extubation. Patients must be fully awake and capable of maintaining patency of their oropharynx in the event of postop swelling and transient obstruction of the nasopharynx.	
Blood and fluid requirements	IV: 24 or 22 ga × 1 NS/LR @ maintenance	Blood loss is usually < 10 mL; may be greater in older infants.
Monitoring	Standard monitors (see p. D-1).	
Positioning	and pad pressure points. eyes.	
Complications	Airway obstruction Bleeding	2° obstruction or displacement of nasal stents into oral pharynx especially in older infants

Postoperative

Complications	See Intraop Complications, above.	
Pain management	Acetaminophen po/pr	Small doses of opioid may be given iv immediately post-op, with special attention to avoid respiratory depression/ obstruction.

Suggested Readings

1. Harris J, Robert E, Kfallfen B: Epidemiology of choanal atresia with special reference to the CHARGE association. *Pediatrics* 1997; 99:363–7.

2. Menasse-Palmer L, Bogdanow A, Marion RW: Choanal atresia. *Pediatr Rev* 1995; 16:475–6.

3. Prescott CA: Nasal obstruction in infancy. *Arch Dis Child* 1995; 72:287–9.

Pediatric Tracheostomy

Surgical Considerations

Description: A **tracheostomy** is performed in the infant or child with upper airway obstruction (subglottic stenosis, laryngeal web, etc.) or in the child in whom prolonged mechanical ventilation is anticipated. In most cases, the child will already be intubated and the procedure will be performed over the ETT. In selected infants, the tracheostomy can be performed with a rigid bronchoscope in the airway through which the patient is being ventilated. A midline *(Print pagebreak 1199)* horizontal neck incision is made just inferior to the cricoid cartilage. The dissection is carried out in the midline until the trachea is reached. In children, the tracheal incision is vertical. Stay sutures may be placed in the right and left sides of the trachea on either side of the incision to facilitate replacement of the tracheotomy tube should it become displaced. Alternatively, a **starplasty** can be performed where the tracheal incision is made in the shape of a "+", the skin incision an "x", and the skin is sutured to the trachea. A large air leak will be present as soon as the tracheal incision is made. As the ETT or bronchoscope is being removed, a tracheostomy tube is inserted in the neck. The ventilation tubing is moved and connected to the tracheotomy tube which is secured with neck sutures and/or ties around the neck. The starplasty has the advantage that in case the tracheotomy tube is dislodged accidentally, it can be fairly easily re-inserted, even on the first postoperative day, providing an additional safety factor over the conventional approach.

Usual preop diagnosis: Ventilator dependence; subglottic stenosis

Summary of Procedures

Position	Supine; head to anesthesia; shoulder roll; neck extended
Incision	Horizontal neck
Special instrumentation	Tracheostomy hook
Unique considerations	Patient is draped to allow easy access to ETT. When trachea is opened, a large air leak may be present.
Antibiotics	Clindamycin 10 mg/kg or cefazolin 25 mg/kg
Surgical time	30 min–1 h
EBL	< 10 mL
Postop care	Close observation in PICU. CXR immediately following procedure to r/o pneumothorax.
Mortality	Intraoperative: rare. Postop 1–3%, usually 2° tracheostomy tube plugging or dislodgement.
Morbidity	Pneumothorax Subcutaneous emphysema Bleeding Infection Plugging Skin abrasion around trach edges or trach ties in patient with short, chubby neck
Pain score	3–5

Patient Population Characteristics

Age range	Newborn–adult
Male:Female	1:1
Incidence	Uncommon
Etiology	Anatomical airway obstruction; ventilatory dependence; high, spinal-cord, or head injury
Associated conditions	Prematurity; trauma

Anesthetic Considerations

See Anesthetic Considerations following Tracheostomy in Chapter 3.0 Otolaryngology (p. 187).