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Otolaryngology—Head and Neck Surgery

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[1]Head & Neck Surgery

[2]Laryngology

[3]Otology & Neurotology

[4]Endoscopic Sinus Surgery

[5]Nasal Surgery

[6]Sleep-disordered breathing

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Introduction—Surgeon's perspective

Interdisciplinary cooperation is nowhere more critical than where the priority of airway maintenance is confronted both with abnormalities in the airway and with adjacent surgical goals. An anesthesiologist versed both in the management of the difficult airway and an ability to accurately anticipate the issues confronting the surgeon is critical. Similarly, a communicative surgeon fully aware of the problems the anesthesiologist is likely to encounter is critical to minimizing complications. Important issues that require mutual understanding include:

a. Airway management: anesthesia induction, endotracheal tube size, head range of motion with shared airway space, a well-secured ETT, postop airway edema, and smooth emergence from anesthesia

b. Muscle relaxation, patient immobility, patient positioning

c. Deliberate relative hypotensive anesthesia and management of bradycardia

d. Antiemetics and pain management postop

e. Patient population considerations: frequent cardiac and pulmonary issues associated with older patients, especially with alcohol and tobacco use; degenerative c-spine issues and prior irradiation affecting neck mobility.

Airway management: An initially compromised airway is not uncommon in many otolaryngology head and neck procedures. Many others may develop airway loss at induction or if premature extubation occurs. Communication between the surgeon and anesthesiologist is essential, as is a discussion of a plan and backup plan should an emergency arise. Availability of a sliding Jackson scope and tracheotomy equipment, as well as plans for fiberoptic intubation, awake intubation, or retrograde intubation should be discussed as indicated.

For procedures within the airway, an endotracheal tube no larger than 6 mm should be adequate, and will reduce postop airway edema. An armored tube is helpful when the surgical procedure is intraoral and the tube may be compressed. A nasotracheal intubation should be discussed as an alternative in this situation. If laser surgery is planned, maintaining the $Fi0_2$ at < 0.3 is indicated. If fiberoptic bronchoscopy is planned, then a 7.0- or 7.5-mm ETT will facilitate passage of the bronchoscope through the ETT, after which for a longer case, changing to a smaller tube may be warranted.

As the patient is generally turned 90° or 180° away from the anesthesiologist, a very secure airway is important. If the surgeon needs access in the mouth, securing the tube via a wire to several teeth may work better than tape.

Muscle relaxation and patient positioning: Avoidance of muscle relaxation is important if a motor nerve, such as the facial nerve, is to be dissected. Muscle relaxation is important, on the other hand, in esophagoscopy and tongue surgery. Communicate and coordinate timing of drug administration. Frequently the surgeon will need to turn the patient's head during surgery. Anticipating this movement when initially securing the endotracheal tube and its connections will prevent disconnection. In neck surgery, the neck is often rotated away from the surgeon; over-rotation presents the risk of brachial plexus stretch injuries. If a radial free flap is anticipated, then positioning of the arm as well as rotation of the head should be carefully coordinated to avoid injury while still providing needed access and a secure airway.

Deliberate relative hypotensive anesthesia, to a SBP of <100 mmHg, depending on individual patient's needs, is often a boon to the surgeon operating in the highly vascular fields of the head and neck, or operating with a microscope. For selected cases the patient also will have had preop embolization of a tumor and its blood supply (e.g., angiofibromas and skull base paragangliomas). **Bradycardia** may occur if the surgeon operates near the vagus nerve or carotid bifurcation. If this occurs, it is usually sufficient for the anesthesiologist to communicate this and the surgeon can desist for a period of time. Occasionally topical or locally injected anesthetics will be necessary.

Introduction—Anesthesiologist's Perspective

Vladimir Nekhendzy

Patients with head and neck cancer are often older smokers with an ↑ incidence of CAD, HTN, chronic renal insufficiency, and COPD. Careful H&P must be performed to ensure that the patient's functional status is optimized before surgery.

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Otolaryngology patients commonly present difficult airway problems. Some of the common features of the H&P, which may be associated with difficult airway include: (a) specific anatomic characteristics (e.g., ↓ C-spine ROM, large tongue, receding jaw, etc.); (b) Hx of stridor and hoarseness (airway narrowing and possible vocal cord dysfunction); (c) previous Hx of neck surgery, trauma, or XRT (↓ compliance of the tissues, ↓ neck ROM, ↓ mouth opening); (d) previous Hx of difficult intubation; (e) oropharyngeal infections (e.g., epiglottitis, retropharyngeal abscess, Ludwig's angina) or tumors. Meticulous examination of the airway must be performed, and an abnormal airway assessment should heighten the anesthesiologist's level of concern.

There should be a low threshold for an awake intubation if the airway is questionable. If a conventional DL after induction of GA is chosen and there is any question about airway management, at least two clearly defined alternative airway management backup plans should be in place with all the corresponding airway equipment prepared prior to induction. The patient's head position should be optimized and simple intubating aids (e.g., stylets, gum elastic bougie, Trachlight), as well as ETTs of different sizes should be available. Video laryngoscopy (e.g., Glidescope) plays an increasingly important role in difficult airway management, and the use of LMA Fastrach reliably provides rescue ventilation with 95–100% success rate in many difficult airway management situations.

For the majority of otolaryngological surgical procedures, the patient's airway must be shared with the surgeon, while immediate access to the airway is difficult because the patient is turned 90° or 180° away from the anesthesiologist. The ETT must be well secured to prevent an accidental extubation, or withdrawal of the ETT to the subglottic area which may result in direct pressure on the recurrent laryngeal nerves by the ETT cuff. For certain procedures (e.g., excision of tumors of the base of the tongue, tongue suspension for obstructive sleep apnea [OSA]), and other intraoral procedures, nasal intubation may be required for surgical access, and the surgeon should be consulted before induction.

The essential anesthesia management requirements for the majority of the otolaryngological procedures include:

a. Assurance of good intraop and postop analgesia (most of the procedures are performed on highly reflexogenic areas).

b. Clear surgical field (the operated areas are highly vascular). Moderate controlled hypotension is widely employed: ↓ SBP < 100 mmHg, MAP = 60–70 mmHg, unless contraindicated 2° concurrent medical conditions.

c. Patient immobility (for certain procedures profound muscle relaxation may be required, while for others (e.g., nerve monitoring) administration of non-depolarizing muscle relaxants must be avoided).

d. Smooth emergence. One of the most challenging tasks, as every attempt should be made to avoid or minimize patient reaction to the ETT during tracheal extubation. Straining, bucking, or coughing may provoke bleeding (↑ venous and arterial pressure), disrupt delicate suture lines (e.g., facial nerve repair), dislodge surgical grafts (e.g., tympanoplasty), or cause additional trauma to the vocal cords (VC) after VC surgery. Many ENT surgeons have their own "list" of procedures where the patient's reaction to the ETT should be completely avoided during extubation, and an anesthesiologist should be familiar with the surgeon's preferences.

With the possible exception of patients presenting for OSA surgery (see Anesthetic Considerations for Reconstructive Surgery for Sleep-Disordered Breathing, p. 255), the **opioid-based anesthetic techniques** are especially advantageous for achieving or facilitating the previously stated anesthetic objectives. The opioid-based techniques also result in significant ↓ MAC and facilitate early elimination of volatile agents, while blunting the tracheal response to the ETT. The choice of an opioid analgesic depends on several factors: the anticipated degree of intraop surgical stimulation, immediate postop pain, duration of surgery, patient's concomitant medical conditions, underlying physical status, and prior opioid use. Highly potent opioids (e.g., fentanyl: loading dose 3–10 mcg/kg; sufentanil: loading dose 0.5–1.5 mcg/kg iv); followed by either intermittent boluses or continuous infusion are the author's preferred choice for major ENT surgery. Continuous iv infusions of opioids offer advantages over intermittent boluses, resulting in ↓ total dose, greater hemodynamic stability, more rapid emergence, less pain in the immediate postop period, and ↓ times to discharge from the recovery room. For highly stimulating procedures followed by minimal or absent postop discomfort (e.g., laser surgery of the airway), shorter-acting opioids are preferred: remifentanil (loading dose 0.5–1.0 mcg/kg iv, infusion 0.1–0.25 mcg/kg/min iv) or alfentanil (loading dose 20–40 mcg/kg iv, infusion 0.25–1.0 mcg/kg/min iv). Total intravenous anesthesia (TIVA) is commonly employed, especially for endoscopic procedures.

Maintenance of **controlled hypotension** can be easily facilitated by administration a potent inhalational anesthetic and/or intermittent iv boluses of the vasoactive drugs (e.g., esmolol 0.3–1.0 mg/kg, labetalol 0.1–0.3 mg/kg, *(Print pagebreak 176)* hydralazine 0.07–0.15 mg/kg). IV infusion of NTG or SNP (0.25–1 mcg/kg/min) is rarely necessary. Additional doses of iv labetalol are almost always beneficial at the end of surgery to prevent rebound hypertension in the early postop period.

Table 3-1. Advantages of the LMA Compared with the ETT

Adverse Event	ETT %	LMA %	Ratio
Clinically significant problems	3.4	0.9	3.8
Laryngeal spasm	0.38	0.12	3.2
Aspiration	0.017	0.02	0.85
Sore throat	50	10	5
Laryngeal trauma	6.2	? (< 1)	> 6
Coughing on emergence	60	2	30

*Modified from Brimacombe JR, Brain AJ: *The Laryngeal Mask Airway. A Review and Practical Guide.* WB Saunders, Philadelphia: 1997.

Antiemetic prophylaxis should be routine, and most commonly is achieved by iv administration of a 5-HT$_3$ blocker. Multimodal antiemetic prophylaxis should be employed for patients at high risk for PONV. The addition of metoclopramide (10–20 mg iv) may be beneficial for patients who have undergone procedures resulting in accumulation of blood in the stomach (e.g., nasal or intraoral surgery).

GETA is most widely employed. Use of an LMA type device for the ENT surgery, when feasible, is often beneficial. An LMA is associated with less stimulating emergence from anesthesia, and a reduction in the number of episodes of coughing, laryngospasm, and laryngeal trauma (Table 3-1).

LMA use is associated with decreased patient morbidity, which otherwise commonly manifests as feelings of "fullness" (25%), transient dysphagia (4–24%), bacteremia (4%), and minor pharyngeal abrasions (2%). The single most limiting feature of the LMA

is the potential for aspiration of stomach contents.

A flexible laryngeal mask airway (FLMA) is most frequently used in ENT anesthesia, because its shaft can be bent away from the surgical field and moved freely inside the patient's mouth to find an optimal angle for connection to the anesthesia circuit. Movement of the FLMA shaft is not transmitted to the cuff, and the FLMA provides a stable airway during maintenance of anesthesia. The FLMA has been used successfully in different ENT procedures, including adenotonsillectomy, ear and nasal surgery, facial plastic surgery and head and neck surgery. Close communication between the surgeon and anesthesiologist is essential, because even a properly placed FLMA can become dislodged during surgical manipulations.

Use of the standard LMA insertion technique is crucial for adequately protecting the larynx from possible aspiration and minimizing the risk of gastric insufflation if positive pressure ventilation (PPV) is planned. Although it may be difficult to predict the optimal FLMA size for the patient, the largest size (FLMA #5) should be used for PPV whenever possible, to minimize the incidence of oropharyngeal leak and gastric insufflation. Gastric insufflation is further avoided by ↓ Vt to 6–10 mL/kg and by keeping PIP < 20 cm H_2O. The absence of gastric insufflation should be documented in the anesthesia record after auscultating the epigastric area. Maintaining neuromuscular blockade during PPV through the FLMA is not essential, but may offer the advantages of ↑ chest wall compliance and ↓ incidence of reflux and regurgitation 2° patient movement or reaction to the FLMA. Suggested use of the FLMA for selected ENT procedures is discussed below.

Suggested Readings

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Laryngoscopy/Bronchoscopy/Esophagoscopy

Surgical Considerations

Description: Laryngoscopy is used for inspection of the pharynx, hypopharynx, or larynx for diagnostic and/or therapeutic benefit. The patient is supine with cervical spine flexed and atlantoaxial joint extended (this position is best achieved with a headrest); and the teeth are protected with a mouth guard. The laryngoscope is introduced (Fig. 3-1); then, with a lifting motion, a thorough examination of the oropharynx, hypopharynx, laryngopharynx, and larynx is carried out and biopsies can be taken. Any bleeding normally can be controlled easily with pressure. Laryngoscopy often is combined with esophagoscopy, bronchoscopy, or direct nasopharyngoscopy to survey the aerodigestive tract for malignancy. If the procedure is diagnostic, the surgeon may need to visualize the airway before intubation and/or muscle relaxation. If a laser is to be utilized, a special laser ETT, < 30% FiO_2, and avoidance of N_2O are required.

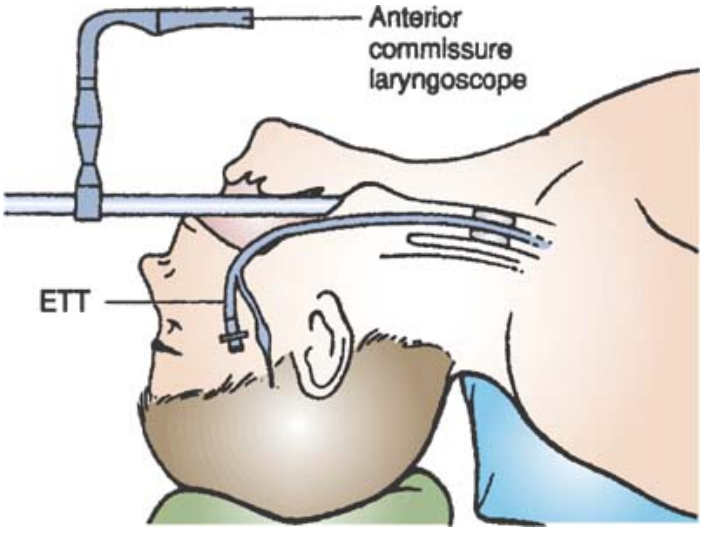

Figure 3-1. Placement of anterior commissure laryngoscope for laryngoscopy.

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Usual preop diagnosis: Oropharyngeal, hypopharyngeal, or laryngeal tumors

Description: Operative micolaryngoscopy. A variety of laryngeal lesions, including papilloma, cysts, and polyps, can be removed endoscopically. Because of their close apposition to the delicate tissues of the vocal fold, a high degree of precision may be needed to remove the growth without damaging the underlying membrane. To this end, specialized endoscopes, such as the Dedo operating laryngoscope, are deployed transorally to allow the surgeon a binocular view of the vocal fold and the target lesion. They can be suspended from a Mayo stand in order to free both of the surgeon's hands for operating. Using the microscope, a variety of specialized endoscopic instruments and the CO_2 laser, the surgeon may be afforded excellent visualization of and unobstructed access to the vocal folds for diagnostic and therapeutic purposes. Operative microlaryngoscopy may necessitate several hours of work. Because of the precision involved in such procedures and the high degree of stimulation to the patient, general anesthesia (± jet ventilation) with muscle relaxation is required. Intubation with a small-caliber microlaryngeal or laser-safe tube (5 or 6 mm) may be required for these procedures. In cases where jet ventilation is to be performed, an endoscope suitable for this technique should be available. Intermittent apnic ventilation is also a possibility, although this involves periodic interruption of surgery, which can be cumbersome and distracting.

Usual preop diagnosis: Vocal fold neoplasm; vocal fold paralysis

Description: Bronchoscopy is used for visualization of the tracheobronchial tree for both diagnostic and therapeutic purposes. The patient is supine with head elevated and neck extended at the upper cervical level. The bronchoscope is directed along the right side of the tongue forward toward the midline to visualize the epiglottis. Next, the bronchoscope tip is used to lift the epiglottis and advance the bronchoscope through the vocal cords, into the trachea and bronchus (Fig. 3-2). The scope can be directed for inspection of the carina, main bronchi, and, with the aid of telescopes, the segmental bronchi.

Flexible fiberoptic bronchoscopy is more commonly performed than rigid bronchoscopy. The endoscope is usually connected to a monitor, and suction, irrigation, and biopsy channels are self-integrated. Spontaneous ventilation *(Print pagebreak 179)* can be maintained which can allow the procedure to be performed without an ETT in place, affording unobstructed visualization of the entire upper airway. A bite block is usually placed to protect the endoscope from dental trauma and to allow easier advancement through the oropharynx into the larynx.

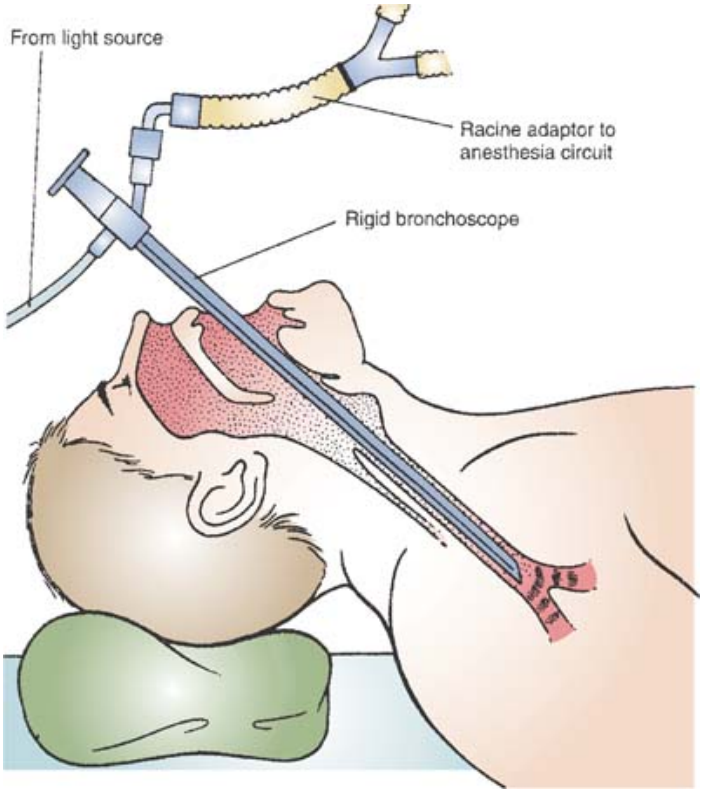

Figure 3-2. Rigid bronchoscopy showing adaptor (Racine) for anesthesia machine. Note neck flexion and head extension to align oropharyngeal and tracheal axes.

Usual preop diagnosis: Head and neck squamous-cell carcinoma; foreign body (FB) in bronchus

Description: Esophagoscopy is used for visualization of the esophagus for either diagnostic or therapeutic benefit. The patient is

supine with head elevated and neck extended at the upper cervical level. The esophagoscope (held in the right hand) is advanced through the mouth behind the arytenoids, gently using the left thumb. The bevel of the scope is then used to advance through the cricopharyngeal muscle (upper esophageal sphincter) with an upward lifting movement, entering the cervical esophagus. As the scope advances, the head may have to be lowered or the neck extended and the scope directed slightly toward the left. It should be advanced only when a visible lumen is seen all the way down to the cardia. **Flexible fiberoptic esophagoscopy** is performed in an essentially identical manner. Superior visualization has made this the technique of choice for many surgeons. Biopsies may be taken and percutaneous gastrostomy tubes may be placed using the fiberoptic esophagoscope.

Usual preop diagnosis: Head and neck squamous-cell carcinoma; FB ingestion

Description: Panendoscopy, or triple endoscopy, is the combination of laryngoscopy, bronchoscopy, and esophagoscopy. It is usually performed as part of the evaluation of patients with newly diagnosed cancer of the head and neck for several reasons: (a) to gauge the extent of the primary tumor and to evaluate resectability; (b) to evaluate for the presence of synchronous tumors in other locations within the upper aerodigestive tract; (c) to identify the source of the primary lesion in patients who present with secondary cervical metastases. In the 3rd case, after PET-CT, endoscopy is supplemented with directed biopsies from those locations most likely to contain the occult primary lesion, including the nasopharynx, tonsillar fossae, and tongue base, with tonsillectomy commonly done as well. Identification of the source of the primary lesion allows for more directed therapy, tailoring irradiation fields with improved local control and overall.

Usual preop diagnosis: Head and neck squamous-cell carcinoma.

Summary of Procedures

	Laryngoscopy	Bronchoscopy	Esophagoscopy	If Therapeutic Procedure Added
Position	Supine			
Special instrumentation	Endoscopes, video monitors, suction			Laser, laser-safe ETT, gastroscope and G-tube (abdominal prep)
Unique considerations	Dexamethasone 4–8 mg if airway edema			If laser ablation, keep O_2< 30%
Antibiotics	None	None	None	cefazolin 1gm and metronidazole 500 mg or clindamycin 600 mg
Surgical time	10–30 min			30–120+ min
EBL	Minimal			typically minimal
Postop care	PACU; rarely 23 h stay 2° airway issues			; depends on specific intervention, if G-tube: monitor for abdominal signs
Mortality	< 1%			
Morbidity	With MDL, Incisor trauma < 1% Airway obstruction or postprocedure edema requiring reintubation: < 1% Esophageal perforation < 1% Laryngospasm: < 5%			; if G-tube placement, <2% abdominal bleed or free air; if MDL with laser of laser bronchoscopy < 1% pneumothorax, < 5% airway compromise
Pain score	1–2	1–2	1–2	1–2

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Patient Population Characteristics

Age range	Newborn–90+
Male:Female	1:1
Incidence	Common
Etiology	Tumors, foreign bodies, congenital webs
Association Conditions	Other congenital issues; if malignancy, prior RT or chemotherapy and the conditions associated with that malignancy

; nutritional need (G-tube)

Anesthetic Considerations

(Procedures covered: bronchoscopy, esophagoscopy, panendoscopy, operative microlaryngoscopy, Zenker's diverticulectomy, laser surgery of the airway)

Preoperative

Many of these patients are elderly and have a Hx of smoking and ETOH abuse with corresponding implications for intraop management. Patient fluid and nutritional status may be further compromised by pre-existing malignancy. Meticulous attention to airway management is paramount in these procedures, and close communication with the surgeon is essential. Some patients presenting for esophagoscopy may have obstructing lesions of the esophagus or **Zenker's diverticulum**, active GI bleeding, or require the removal of a FB, putting them at ↑ risk of aspiration.

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Airway	Although rare, the airway may be compromised in these patients at both the upper and lower airway levels; thus a thorough preop airway assessment is essential. A clear backup plan for securing the airway should be devised and discussed with the surgeon before induction of GA. Stridor at rest suggests an airway narrowing ≤4.5 mm, although the airway diameter can be seriously reduced even without stridor being present. Inspiratory stridor usually is associated with supraglottic lesions, while expiratory stridor suggests airway narrowing below the glottis. Glottic lesions are characterized by both inspiratory and expiratory stridor. Patients with lesions in the mediastinum may have involvement of the recurrent laryngeal nerve, presenting with hoarseness and potential airway management problems (e.g., difficult mask ventilation, difficult intubation, ↑aspiration risk, aspiration risk). (See also Anesthetic Considerations for Laryngectomy, p. 202)
Respiratory	These patients may have a high incidence of COPD and ↓ respiratory reserve. The nature and characteristics of a productive cough must be noted. Wheezing on exam must be treated with bronchodilators before induction. Patients presenting with vocal cord (VC) paralysis or achalasia may have had the repeated episodes of pulmonary aspiration. **Tests:** CXR; other tests as indicated from H&P.

Dental	Physical exam should include a careful dental assessment and documentation of any missing, loose or damaged teeth. Patients (or parents, as appropriate) should be informed that dental trauma may occur as a result of surgical instrumentation of the patient's mouth during the procedure.
Cardiovascular	Adrenergic responses during endoscopy may be associated with up to a 4% incidence of myocardial ischemia. Careful preop Hx and thorough physical exam should be undertaken in patients with Hx of CAD and CHF, or those with cardiac risk factors (including age > 40 yrs, male, HTN, hypercholesteremia, long Hx of smoking, obesity, and family Hx). The volume status of debilitated patients who are unable to eat because of obstructing lesions of the esophagus should be assessed by measuring orthostatic BP changes. **Tests:** ECG; Other tests as indicated from H&P.
Neurologic	Some patients may have Hx of ETOH abuse, which may result in ↑ anesthetic requirements 2° hepatic enzyme induction. Symptoms of alcohol withdrawal (e.g., tremulousness, ↑ sympathetic activity, and altered mental status), if present, should be controlled before surgery.
Hematologic	Patients with malignancy or chronic disease may have evidence of anemia or coagulopathy. **Tests:** CBC; coagulation studies as indicated from H&P
Gastrointestinal	In some patients (e.g., with malignant tumors), significant electrolyte abnormalities may be present 2° malnutrition. Hypokalemia and hypomagnesemia should be corrected preop. In patients with Hx of ETOH abuse, liver disease and cirrhosis may be present. **Tests:** Electrolytes; BUN; Cr; LFT; coag studies, as indicated from H&P.
Premedication	An antisialogogue (e.g., glycopyrrolate 0.2 mg iv) may be desired by the surgeon to faciliate panendoscopy, especially in patients with copious secretions. Sedative premedication is routine, but should be minimized in the elderly and avoided in patients with symptoms of upper airway obstruction.

Intraoperative

Anesthetic technique: GETA. Airway management requires careful planning and continuous communication with the surgeon. Surgical requirements include adequate muscle relaxation (movement, coughing, or bucking during endoscopy may have disastrous consequences) and immobile vocal cords for vocal cord surgery. Cardiovascular stability is important: laryngeal, tracheal, and carinal reflexes may provoke severe ↑ BP and ↑ HR, which can be detrimental in some patients. Adequate depth of anesthesia is essential, but the requirements for rapid awakening and return of laryngeal reflexes present additional challenges in anesthetic management. Short-acting β-blockers (e.g., esmolol) may be indicated to treat break-through sympathetic responses, especially in patients with cardiac disease. Use of short-acting opioids (see Introduction, p. 174) is useful for these procedures which, although highly stimulating, are characterized by minimal or absent postop pain, and the majority of patients are discharged home from the recovery room.

Special considerations: If **flexible bronchoscopy** is planned, the patient's trachea is intubated in routine fashion by the anesthesiologist with a large diameter ETT (7.5–8.0 mm ID) to acommodate a flexible video bronchoscope. The ETT is usually taped midline. As an alternative, in selected patients, flexible bronchoscopy can be performed without tracheal intubation through the **Patil-Syracuse mask** during manual bag-mask ventilation. Placement and manipulation of the flexible bronchoscope by the surgeon will be facilitated by the concomitant use of one of the hollow oral airways used for the fiberoptic intubation (e.g., **Williams airway**). This approach is useful when intraoral surgical manipulation is planned, as the patient can then be tracheally intubated with a smaller diameter ETT (e.g., 6.0 mm ID), to facilitate surgical access.

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Flexible esophagoscopy is rarely performed as an isolated procedure, but if done, would also be facilitated by tracheal placement of

a small diameter (e.g., 6.0 mm ID) ETT; the ETT is usually moved over to the left corner of the mouth and taped to the lower jaw, to provide more room for the esophagoscope advancement and manipulation.

If **rigid bronchoscopy** is planned first, GA is induced, and the patient is hyperventilated through the face mask with FiO_2=1.0. Following muscle relaxation, the surgeon may proceed, without securing an airway. Quick and gentle DL for application of topical lidocaine to the larynx and upper trachea (LTA, 4% lidocaine 3–4 cc) before rigid bronchoscopy may help blunt hemodynamic responses to the subsequent surgical manipulation. DL with LTA should be avoided in patients with tumors at the base of the tongue (↑ risk of bleeding) (see Anesthetic Considerations for Glossectomy, p. 209) or when pre-existing copious secretions or bleeding are present in the upper airway 2° ↑ risk of pulmonary aspiration on emergence from anesthesia. It is advisable to demonstrate to the surgical team and document in the chart absence of dental damage after DL has been performed.

After the rigid bronchoscope is introduced into the patient's trachea, it is connected to an anesthesia circuit through a flexible side port adapter (Racine, Fig. 3-1), and the patient is ventilated manually. High flows are usually required because of the leak around the bronchoscope. Close communication with the surgeon is essential for adjusting ventilation when the bronchoscope is introduced into the mainstem bronchus to avoid high inflating pressures and to assure complete exhalation (↓ risk of barotrauma). After rigid bronchoscopy is completed, mask ventilation with FiO_2=1.0 before intubation is advisable to assure adequate oxygenation and normocapnia. A reinforced ETT is useful for **rigid esophagoscopy** to avoid possible compression of the ETT. The ETT should be moved to the left side of the patient's mouth to facilitate introduction of the surgical instruments, and taped to the lower jaw because full opening of the patient's mouth is required.

For **operative microlaryngoscopy,** a small-diameter (usually 5.0 mm ID), cuffed long microlaryngeal tube (MLT) is used to facilitate visualization of the larynx. The CO_2 laser, which can precisely vaporize superficial tissue, is widely used for vocal cord **laser surgery**, while the Nd:YAG (neodymium-yttrium-aluminum-garnet) laser is usually employed for airway tumor debulking because of its ability to coagulate deeper lesions. The Nd:YAG can be used through the suction channel of the fiber optic or video bronchoscope, whereas the CO_2 laser must be aimed directly at the targeted tissue. Both the CO_2 and Nd:YAG wavelengths lie outside the visible spectrum, and a separate, lower energy visible beam is used for aiming. The patient must be motionless, the patient's eyes must be protected with tape and moistened gauze, and OR personnel must wear protective goggles.

An **intermittent apnea technique** involves hyperventilation, followed by intermittent tracheal extubation for 1–5 min, during which the laser is used. This approach is time-consuming and may be associated with a higher incidence of airway trauma and edema 2° repeated intubations. Careful pulse oximeter monitoring is essential for this technique.

Jet ventilation (Fig. 3-3) may be necessary when an ETT cannot be used (e.g., some supraglottic and subglottic lesions). For supraglottic jet ventilation, the ventilating laryngoscope is most commonly employed. The axis of the jet should be in line with the trachea, and full egress of air (complete chest deflation) should be assured between the jet ventilator "puffs." Close communication with the surgeon is essential. The jet should be triggered during pauses between laser firings to keep the vocal cords immobile. If jet ventilation is used for laser resection of papillomas, there is a risk of spreading the virus to OR personnel, and special face masks should be worn in the OR. Jet ventilation generally provides adequate ventilation without introducing flammable material or obstructing the surgical field. Its use, however, may be associated with potentially severe complications, including barotrauma, pneumothorax and gastric distension (risk of regurgitation), and is hindered by ↓ chest-wall or lung compliance. Full muscle relaxation is absolutely essential with this technique, to facilitate precise laser firing. High-frequency jet ventilation can also be used through a catheter passed below the vocal cords into the patient's trachea, but this requires special equipment that is not widely available. Its advantages include excellent operating conditions and improved cardiovascular stability, but it may be associated with a higher incidence of barotrauma, laryngospasm and hypoventilation.

For laser cases, precautions must be taken to prevent **airway fire**, including:

- Use special laser ETT (e.g., Mallinkrodt Laser-Flex, Xomed Laser Shield), although none of them provides 100% protection from all types of lasers. Small (5.0 mm ID and smaller) diameter laser ETTs are preferred to facilitate surgical access.
- Use the lowest possible FiO_2 ($\leq$ 0.3–0.4 strongly preferred), that will assure adequate oxygenation (dilute O_2 with air, N_2, or helium) and avoid N_2O (both O_2 and N_2O promote combustion).
- Use colored (methylene blue-tinged) NS in the ETT cuff (will immediately alert the surgeon in case of a laser hit).
- Place the ETT sufficiently deep into the trachea for the cuff to be out of surgical sight.

Similar considerations apply in patients undergoing endoscopic **Zenker's diverticulectomy**, when the CO_2 laser is used.

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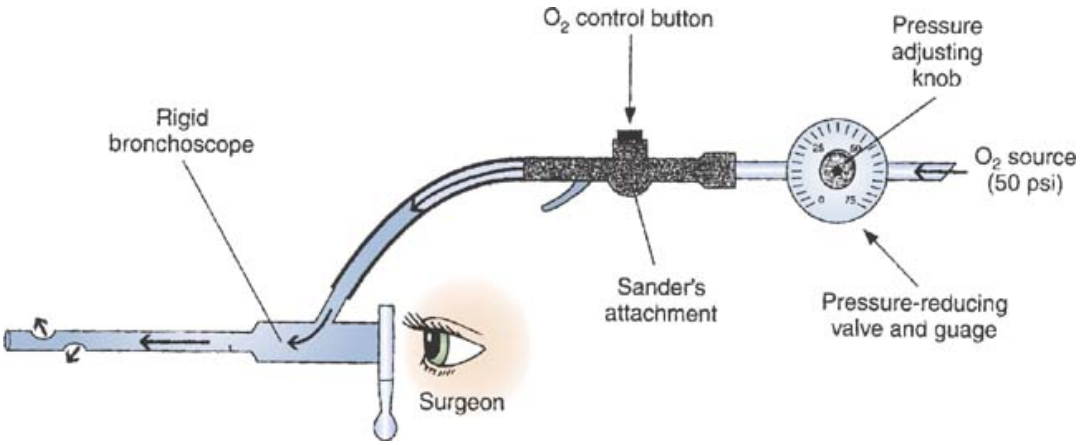

Figure 3-3. Rigid bronchoscope with modified Sanders jet ventilation technique. The wall oxygen supply at 50 psi is connected to a reducing valve that allows the pressure to be adjusted from 0 to 50 psi. The side port of the bronchoscope is used as the Venturi injector site, and the open end can be used for continuous viewing by the endoscopist.

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Induction

Patients at risk for aspiration (e.g., **Zenker's diverticulum**) may require RSI with cricoid pressure (CP) if symptoms of active gastroesophageal reflux disease are present. Otherwise, anatomical location of the diverticulum (above the cricoid cartilage) makes application of CP largely ineffective. With the possible exception of endoscopic Zenker's diverticulectomy, fentanyl use should be minimized (1–2 mcg/kg) or even completely avoided in favor of the short-acting opioids (remifentanil or alfentanil IV (see Introduction, p. 174), 2° minimal postop pain. Propofol (1–2 mg/kg) is the ideal induction agent. Patients with mobile, floppy, supraglottic tumors (e.g., papillomatosis, epiglottic cancer, large vocal cord polyps) are at ↑ risk for complete airway obstruction after induction of GA with or without neuromuscular blockade. Anesthetic management of these patients requires careful planning and meticulous preparation (see Anesthetic Considerations for Laryngectomy, p. 202.) The surgeon should be consulted about the extent of the disease and the potential need for a tracheostomy. If the disease is severe, the surgeon should be present during induction for the possible need to perform urgent or emergent rigid bronchoscopy or cricothyrotomy/tracheostomy.

Maintenance

TIVA (e.g., propofol: 80–180 mcg/kg/min; remifentanil 0.1–0.25 mcg/kg/min) is widely used, especially when rigid bronchoscopy or jet ventilation/intermittent apnea techniques are planned. Compared to alfentanyl, the use of remifentanil during TIVA is associated with the increased hemodynamic stability, reduction in propofol dose and faster respiratory recovery. When the ETT is used throughout the case, delivery of anesthetic gases may be used instead of a propofol infusion, especially if a bronchodilating effect is desirable. Desflurane and sevoflurane are the preferred agents because of their low blood:gas solubility; sevoflurane may be favored in patients with pre-existing cardiac disease to minimize the risk of a dose-dependent tachycardia. Break-through sympathetic responses can be managed safely by administration of β-blockers IV or small boluses of a short-acting opioid (see Introduction, p. 174). With intermittent apnea or jet ventilation techniques, it may be difficult to avoid hypercapnia and hypoxemia, which may provoke intraop dysrhythmias.

Full muscle relaxation is routine: vocal cord immobility is essential for microlaryngeal and laser surgery. Monitoring the neuromuscular blockade may be more accurate at the facial nerve (orbicularis oculi muscle), than the ulnar nerve (adductor pollicis muscle), because the recovery of the former better reflects the recovery of the laryngeal muscles. If this method is chosen, care should be taken to avoid inadvertent prolonged neuromuscular blockade by coordinating administration of additional doses of muscle relaxants with the surgeon. As the surgery approaches its end, deepening the level of anesthesia may be the preferred approach to minimize VC movement. A succinylcholine infusion (2–6 mg/min iv) can be used safely in selected patients (limiting the total dose of succinylcholine ≤ 4–6 mg/kg will help avoid phase 2 block).

Emergence	Patient should have full return of protective airway reflexes prior to extubation. The patient's stomach should be decompressed following jet ventilation. Smooth emergence from anesthesia is obligatory to avoid additional trauma to the vocal cords. For this reason, some surgeons request deep extubation after vocal cord surgery, which presents extra challenges to the anesthesiologist (see Emergence for Tonsillectomy, Adenoidectomy, p. 205).	
Blood and fluid requirements	IV: GI bleeder: 14–16 ga × 2 Others: 20 ga × 1 NS/LR @ 2–3 mL/kg/h For esophagoscopy: NS/LR @ 4–6 mL/kg/h	Blood loss is usually minimal; however, in patients with ↑ risk of GI bleed, blood loss may be massive. T&C these patients for 2 U PRBC with blood immediately available in OR.
Monitoring	Standard monitors (p. B-1). ± arterial line	In patients with ↑ risk of GI bleed, an arterial line is desirable
Positioning	OR table rotated 90° or 180° away from the anesthesiologist and pad pressure points. eyes.	A shoulder roll is placed and the patient's neck is extended to facilitate endoscopy. Special attention should be paid to prevent compression of the patient's shoulder by the vertical bar of the Mayo stand which is frequently employed for suspending the operating laryngoscope or endoscope. Hypoxia and hypercarbia may be difficult to avoid with jet ventilation
Complications	Inadequate ventilation Loss of airway Perforation of airway Dysrhythmias Pneumothorax	Mechanical or laser perforation of the airway may → bronchospasm or uncontrollable hemorrhage. Dx: ↑RR, ↓BP, ↑CVP, wheezing, ↓O_2 saturation, ↑PIP, SOB, chest pain, ↓breath sounds, ↓ECG amplitude, dullness on percussion. Rx: chest tube or needle aspiration, FiO_2=1.0, ventilation and volume expansion.
	Eye trauma Bleeding post-biopsy	Eye trauma from surgical instruments used during endoscopy may require ophthalmology consult.
Airway fire (steps taken **simultaneously** by the anesthesiologist and surgeon)	Disconnect the inspiratory limb of the anesthesia circuit. Extinguish fire with NS. Remove ETT after deflating cuff. Extinguish and remove all burning material. Resume ventilation by face mask with FiO_2 = 1.0. Flexible fiberoptic bronchoscopy. Save ETT for later examination.	This is an acute, life-threatening emergency. NB: turning ventilator off only may not be sufficient due to continued delivery of fresh gas to the patient's lungs. Rigid or flexible bronchoscopy is required to extent of damage, presence of ETT fragments, and airway edema. All inhaled gases should be humidified. Patients are usually reintubated and monitored in the ICU.

Postoperative

Dental trauma may result from surgical manipulation of the airway, and the anesthesiologist must check the teeth immediately after airway access is gained. If dental trauma is detected, notify the

		surgeon to discuss management options, both immediate and subsequent.
	Dental trauma Bleeding Eye trauma	
	Postop airway compromise	Has a higher incidence than in general surgery patient population. Patients with T3 lesions and those with associated laryngeal biopsy (↑ airway swelling) after panendoscopy may be at high risk for reintubation in PACU. Delayed upper airway edema after laser surgery has been described, when the coagulation (Nd:YAG) laser is used.
Complications		
	Esophageal perforation Pneumothorax Pneumomediastinum Hemothorax Aspiration	Complaints of painful swallowing as well as fever, tachycardia, neck/chest/back pains postop may suggest an eso-phageal perforation. Pneumothorax (see above), mediastinal air or hemothorax from esophageal perforation may present as ↓ BP and cardiovascular collapse.
Pain management	Short acting opiod	Fentanyl 25–50 mcg iv prn is usually sufficient.
Tests	CXR	For evidence of pneumothorax, hemothorax, mediastinal air.

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Tracheotomy/Tracheostomy and Cricothyroidotomy

Surgical Considerations

Description: When an airway needs to be obtained right away and intubation is not an option, a cricothrotomy is indicated. A vertical incision is made in the midline through the cricothyroid membrane, an initial influx of air is facilitated if the patient is spontaneously breathing, and a small ETT placed. It is wise to convert this to a tracheostomy as soon as it is convenient to do so as this reduces the subsequent incidence of subglottic stenosis and cricoid chondritis.

A tracheotomy is generally done in a controlled setting, either under general anesthesia in an intubated patient or under local anesthesia. Either a short transverse incision 1–2 cm inferior to the cricoid or a midline vertical incision beginning at the same location may be used. Strap muscles are retracted laterally, the thyroid isthmus is divided if necessary, and in adults an inferiorly based tracheal flap consisting of the 2nd or 3rd tracheal ring is made and secured to the skin inferiorly. In small children, it is better to make only a vertical midline incision to minimize the incidence of stenosis; left and right stay sutures are then placed to assist in reintubation in the event of accidental dislodgment of the tracheotomy tube. The tracheotomy tube in all patients is secured to the skin with sutures. Trach ties supplement this securing of the tube unless these circumferential ties would interfere with venous drainage of a flap used in the head and neck reconstruction.

When prolonged use of a tracheotomy is anticipated and it is unlikely that mechanical ventilation will be needed, there are specialized silicon tracheotomy tubes with minimal intraluminal plastic and may be associated with fewer intaluminal potential complications.

Usual preoperative diagnosis: Indications for tracheostomy are numerous, but share the common theme of securing a safe airway either in anticipation of postop airway edema, inability to protect the airway from aspiration, or as an urgent need to obtain an upper airway in pending obstruction. The fastest way to obtain an airway in an outright emergency when intubation is not an option is a cricothrostomy. Another 3rd general inidication is to protect the larynx from injury if prolonged intubation is anticipated, such as in a prolonged ICU setting or in paralysis associated with cervical spinal cord trauma. Rarer indications are bilateral vocal cord paralysis or a history of recurrent allergy associated with larynogspasm.

Summary of Procedures

	Tracheostomy	Cricothyrotomy
Position	Supine, head extended	
Incision	Transverse or vertical	Stab incision through cricothyroid membrane

Special instrumentation	None (most institutions have a “trach set”)	Scalpel is all that is initially needed in this emergency setting
Unique considerations	Local or general, intubated or not. Specialized equipment and silicon trach cannulas selectively arranged for.	
Antibiotics	None	
Surgical Time	3–20 min	30 sec–2 min
EBL	Minimal	
Postop Care	Warm humidification; suctioning; changing inner cannula; skin care; monitor for bleeding and dislodgement; in emergency remove entire tracheotomy tube	; convert to tracheotomy as soon as convenient
Mortality	<1%	
Morbidity	Bleeding <5% cellulitis/tracheitis <5% tracheal stenosis <1%	Subglottic stenosis risk if not converted
Pain score	1–2	2–4

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Patient Population Characteristics

Age range	All	
Male:Female	Dependent on underlying condition	
Incidence	Common	
Etiology	Anticipated airway obstruction, airway obstruction, prolonged intubation	Trauma
Associated conditions	Dependent on underlying c ondition, but typically cardiopulmonary or neurological conditions	Trauma

Anesthetic Considerations

Preoperative

Typically, there are three patient populations presenting for tracheostomy: (a) critically ill intubated patients in chronic respiratory failure or following major trauma; (b) patients for whom tracheostomy is part of a scheduled procedure (e.g., laryngectomy); (c) patients with impending or total upper airway obstruction (e.g., Ludwig's angina, retropharyngeal abscess). If the latter constitutes life-threatening emergency, tracheotomy/cricothyroidotomy may be the preferred approach. Aside from an occasional otherwise healthy patient in the 3rd category, all patients presenting for tracheostomy are usually debilitated, have associated cardiac or pulmonary disease, with neurological and metabolic abnormalities.

Respiratory	Patients in group 1 usually require mechanical ventilation with PEEP to maintain adequate oxygenation. The continued application of PEEP may be an important consideration during their transport from ICU to OR. Patients in group 2 require a careful airway evaluation (see Anesthetic Considerations for Neck Dissection, p. 216, and Laryngectomy, p. 202). Based on the assessment, the anesthesiologist must decide whether to choose a DL, an awake FOI, or a tracheostomy under local anesthesia to secure the airway. Patients in group 3 will usually require semi-emergent or emergent tracheostomy. Patients in all

	three groups should be evaluated for the presence of possible recurrent aspiration. **Tests:** CXR; ABG, as indicated from H&P
Cardiovascular	All patients may have significant cardiac risk factors, including smoking, ETOH abuse, male gender, ↑ cholesterol, family Hx, and HTN. Some patients may have recently undergone major cardiac surgery, and may be on pharmacological inotropic support, with full invasive monitoring, including PA line. **Tests:** ECG, and other tests as indicated, in patients of the 2nd group.
Neurological	Preop neurological deficits should be fully documented
Hematologic	In cases of malignancy or chronic disease, coagulopathies or anemia may be present **Tests:** CBC; Coagulation studies
Laboratory:	Other tests as indicated from H&P
Premedication	Standard premedication (p. B-1) in elective cases. Premedication is best avoided in critically ill patients and patients with symptoms of upper airway obstruction

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Intraoperative

Anesthetic technique: GETA in intubated patients, or in patients who pose no problems for conventional DL and tracheal intubation. In the presence of significant airway compromise or anticipated very difficult intubation local anesthesia may be required. Most tracheostomies are elective or semiurgent, and are performed under GA. Patients with ↑ mucosal swelling (e.g. generalized edema, prolonged intubation) and ↑ tissue fragility (e.g. chronic steroid therapy) are at risk for tracheal mucosal separation → creation of a false passage during tracheostomy. This will constitute a true emergency (see Postoperative Complications, below).

Induction	If already intubated (group 1, above), convert pre-existing ICU sedation to GA, using carefully titrated induction (e.g., etomidate 0.2–0.3 mg/kg iv) or an inhalational agent. If not intubated, and no airway problems are anticipated, a standard induction (p. B-2) may be appropriate. If airway problems are anticipated, an awake FOI or tracheostomy performed under local anesthesia may be the techniques of choice (see Anesthetic Considerations for Neck Dissection, p. 216, and Laryngectomy, p. 202). In any event, the anesthesiologist should be prepared to deal with a failed intubation, and have a surgeon immediately available to perform cricothyrotomy/tracheostomy if ventilation proves impossible.
Maintenance	Standard maintenance (see p. B-2). Full muscle relaxation is required. FiO_2 1.0 usually is required before insertion of the tracheostomy tube. This high O_2 concentration, combined with electrocautery, may precipitate airway fire (see Postoperative Complications, below). A cuffed ETT should be used to prevent O_2 from leaking into the surgical site. In order to avoid inadvertent ETT cuff puncture, consider advancing the ETT closer toward the carina, before the trachea is opened. The trachea is usually opened above the cuff, and the ETT is slowly retracted cephalad, under direct vision by the surgeon (NOTE: Do not remove the ETT completely!). Sterile gas sampling tubing, extra ETTs and anesthesia circuit should be readily available (see Maintenance for Laryngectomy, p. 203). After the tracheostomy tube is secured, it should be suctioned and connected to the anesthesia circuit. Verify the $ETCO_2$ tracing, the inflation pressures, and remove the ETT.
Emergence	Considerations for group 2 and 3 patients are described above. Patients in the first group will continue on ventilatory support in the ICU. The tracheostomy tube must be carefully suctioned and the delivered O_2 should be humidified. Opioid sedation will minimize reaction to suctioning in the early postop period. Tracheostomy tubes should not be removed for at least the first 5–7 days until a track is formed.

Blood and Fluid Requirements	IV: 18ga × 1 NS/LR @ 2–3 mL/kg/h	EBL is typically minimal, when the tracheostomy is performed as an isolated procedure
Monitoring	Standard monitors (p. B-1)	Avoid ECG pad placement in the prepped area. Invasive monitoring may be appropriate depending on the patient's condition.
Positioning	Shoulder roll and pad pressure points. eyes.	A shoulder roll is usually placed, and patient's neck extended, which may result in ETT cuff migrating cephalad, closer to the incision site (danger of inadvertent perforation by the surgeon on entering the trachea!). Make sure the ETT is positioned at the sufficient depth and taped securely.
Complications	Pneumothorax Pneumomediastinum Hemorrhage Aspiration of blood False tracheal passage/tracheal disruption	Pneumothorax may occur with a low neck dissection, or if a false passage (see Postop Complications, below) has been created during the tracheostomy tube insertion. Dx and Rx – see Anesthetic Considerations for Laryngoscopy/Bronchoscopy/Esophagoscopy, p. 180.
	Difficult ETT insertion/reinsertion	This is an airway emergency, and must be quickly recognized (absent CO_2 ↑ PIP, absent or very distant breath sounds). Reintroduction of the existing ETT from the proximal trachea should be attempted. Rigid bronchoscope should be available to reestablish the airway, in case of a failed reintubation. An alternative approach is to insert a large bore iv catheter into the tracheal lumen distal to the tracheostomy site and jet-ventilate the patient. Insertion of an airway exchange catheter through the bronchoscopy elbow adapter attached to the existing ETT has been advocated prior to tracheostomy tube insertion in patients at high risk for this complication.
	Airway Fire	Tracheostomy fires are usually not as catastrophic as other airway fires, possibly because the tracheostomy acts as a vent. Rx: immediately disconnect the patient from the anesthesia machine, extinguish the fire with NS and ventilate the lungs with room air using a self-inflating bag. Removing or changing the existing ETT at this point may be more risky than leaving it in, especially if the patient was previously difficult to intubate or the airway has become edematous.

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Postoperative

	Pneumothorax	See Postoperative complications after Laryngoscopy/Bronchoscopy/Esophagoscopy, p. 185.

Complications	Pneumomediastinum Hemorrhage Occlusion of the tracheostomy tube Tracheostomy tube displacement	This could be due to secretions, mucus plug, blood or positioning of the tube in the mainstem bronchus or against the tracheal wall. Reintubate orally or through the tracheostomy site
Pain management	PCA (p. C-3) IV opioids	
Tests	CXR	tracheostomy tube position and for evidence of either pneumothorax or pneumomedias-tinum

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Intubation for Epiglottitis

Anesthetic Considerations

Preoperative

Epiglottitis is an acute inflammation and swelling of the epiglottis, associated with a generalized systemic toxicity, usually due to *Haemophilus influenza* Type B. It also can be caused by β-hemolytic streptococci, staphylococci, pneumococci, or unusual pathogens among immunocompromised individuals and drug/alcohol abusers. It occasionally results in total laryngeal obstruction and death 2° asphyxia. At one time, the typical patient was a previously healthy child 3–5 yr old; however, since the advent of the H-flu vaccine, epiglottitis is more common in adults (predominantly males). The most common presenting symptoms are sore throat, dysphagia/odynophagia, fever, respiratory difficulty, and drooling. Pediatric patients may appear toxic on presentation.

Airway	Enlarged epiglottis seen frequently on neck x-ray. Neck tenderness or swelling also observed in some patients. Patients with stridor are at high risk for upper airway obstruction.
Respiratory	The patient, typically sitting upright, may display hoarseness, muffled voice, dyspnea, and chest-wall retractions. **NB:** Rapid treatment should be instituted instead of performing time-consuming investigations. The sudden development of respiratory obstruction in the x-ray suite could have a disastrous outcome.

Hematologic	A high leukocyte count usually is found in these patients. **Tests:** Blood drawing before the airway is secured may be inadvisable.
Premedication	None

Intraoperative

Anesthetic technique: GETA. Patients presenting with imminent or actual airway obstruction should be intubated immediately. Airway management for **adult** patients presenting with **mild-to-moderate** symptoms is controversial. Although routine prophylactic intubation of these patients may not be necessary, 18% subsequently develop complete airway obstruction; thus, close monitoring is mandatory if intubation is deferred. It is imperative to realize that total airway obstruction can occur suddenly and without warning.

An experienced anesthesiologist should be present for this procedure. In the pediatric patient, it is critical that neither visualization of the epiglottis nor other maneuvers be attempted to confirm the Dx before anesthesia. In adults, it has been suggested that indirect laryngoscopy or FOB may be performed without the risk of precipitating complete airway obstruction, although this approach is controversial.

Induction	If an iv is in place, atropine 0.02 mg/kg may be given to the pediatric patient to prevent vagal reflexes resulting from manipulation of the inflamed epiglottis. If no iv access is available, inhalation induction (sevoflurane in FiO_2 1.0) with the patient in the sitting position should be used. Intramuscular injection should be avoided to prevent agitation, crying, and subsequent total airway obstruction (iv line is placed after induction of anesthesia). An experienced ENT surgeon, ready to perform an emergency tracheostomy, must be present at induction. Early application of CPAP is essential to maintain the upper airway patency. Inhalation induction may be prolonged and intubation extremely difficult. Different sizes of ETTs must be available.	
Maintenance	Standard maintenance (see p. B-2).	
Emergence	The patient will remain intubated for 24–48 h and should be kept sedated and restrained to prevent accidental extubation.	
Blood and fluid requirements	IV: 18–20 ga (adult) 22–26 ga (child) NS/LR @ 3–5 mL/kg/h (adult); @ 1.5 mL/kg/h (child)	Minimal blood loss Fluid requirements may be ↑ 2° fever and dehydration.
Monitoring	Standard monitors (p. B-1)	
Positioning	and pad pressure points. eyes.	
Complications	POPE (postobstructive pulmonary edema)	A short-lived POPE occasionally occurs after relief of the obstruction and must be treated with IPPV.

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Postoperative

Complications	Accidental extubation ETT blockage	These complications can prove fatal. The blockages are sometimes due to crusting of the ETT 2° insufficient humidification.
Pain management	PCA (p. C-3) IV opioids	Postop sedation and manual restraints are often required

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Zenker's Diverticulectomy

Surgical Considerations

Description: Zenker's diverticulum is a herniation of mucosa through the posterior hypopharyngeal wall immediately above the cricopharyngeus muscle and below the inferior constrictor in an area called Killian's dehiscience. This is an acquired disorder, usually seen in the 6th to 9th decades of life and felt secondary to tonic spasm or achalasia of the cricopharyngeus muscle. Clinically, patients may experience dysphagia, globus, coughing, and regurgitation of undigested food. Weight loss and aspiration pneumonia can be seen in severe cases. Barium swallow is usually diagnostic. Endoscopy will reveal the presence of a pouch of variable size posterior to the cricopharyngeus muscle often filled with undigested debris. Cricopharyngeal achalasia may present in the absence of a well-formed diverticulum with much the same symptom complex. Treatment is usually aimed at division of the cricopharyngeus muscle and eradication of the pouch.

Variant approaches. Open: Under GA with muscle relaxation, an incision is made in the left side of the neck to expose the diverticulum and cricopharyngeus muscle. The muscle is cut, the diverticulum resected, and the hypopharyngeal defect closed. In patients with pure cricopharyngeal spasm, the muscle alone is cut. A drain is placed and *(Print pagebreak 192)* the wound is closed. A nasogastric tube may be placed for postop feeding. Aspiration precautions should be observed at both induction and reversal of anesthesia, as this is a common comorbidity in patients with Zenker's diverticulum. **Endoscopic:** Selected patients may be candidates for endoscopic treatment of a Zenker's diverticulum. This is better described as diverticulotomy rather than diverticulectomy, because the redundant hypopharyngeal mucosa is not removed, and the cricopharyngeus muscle is not divided in its entirety. Rather, the common wall separating the diverticulum from the esophagus is reduced so as to prevent food and debris from collecting within the confines of the diverticulum. With the patient under general anesthesia and muscle relaxation, an esophagodiverticuloscope is placed transorally and advanced into the hypopharynx. The endoscope is deployed so as to visualize clearly the opening into the diverticulum. The common wall separating the diverticulum from the true esophageal inlet is then cut, either with a stapler or with a CO_2 laser.

Usual preop diagnosis: Dysphagia; Zenker's diverticulum; cricopharyngeal spasm

Summary of Procedures

	Open	Endoscopic
Position	Supine; table 90°; head extended	**Supine**
Special instrumentation	Anode or laser ETT; microscope	; endoscopic stapler or CO_2 laser
Unique considerations	Keep O_2 < 30 % and avoid N_2O if lasering.	
Antibiotics	Cefazolin 1gm and metronidazole 500 mg; clindamycin 600 mg	
Surgical time	1–2 h	30 min to 1 h
EBL	< 25 mL	0–25 mL

Postop care	Reflux precautions should be observed; patients may require nasogastric tube feeding for several days	Reflux precautions should be observed
Mortality	< 1%	**< 1%**
Morbidity	Fistula formation < 5% Vocal cord paralysis Hematoma 1–5% Infection 1–5% Aspiration	Perforation < 5% Aspiration
Pain score	3–5	**3–5**

Patient Population Characteristics

Age range	60–90
Male:Female	1.5:1
Incidence	1 in 50,000; Caucasians
Etiology	GERD; neurogenerative disorders
Associated conditions	GERD

Anesthetic Considerations

(See page 180)

(Print pagebreak 193)

Suggested Readings

1. Aly A, Devitt PG, Jamieson GG: Evolution of surgical treatment for pharyngeal pouch. *Br J Surg* 2004; 9(6):657–64.

2. Dohlman G, Mattsson L: The endoscopic operation for hypopharyngeal diverticula: a roentgencinematographic study. *Arch Otolaryngol* 1960; 71:744–52.

3. Feeley MA, Righi PD, Weisberger EC, et al: Zenker's diverticulum: analysis of surgical complications from diverticulectomy and cricopharyngeal mytomoy. *Laryngoscope* 1999; 109(6):858–61.

4. Huang B, Payne WS, Cameron AJ: Surgical management for recurrent pharygoesophageal (Zenker's) diverticulum. *Ann Thoracic Surg* 1984; 37(3):189–91.

5. van Overbeek JJ: Pathogenesis and methods of treatment of Zenker's diverticulum. *Ann Otol Rhinol Laryngol* 2003; 112 (7):583–93.

6. Witterick IJ, Gullane PJ, Yeung E: Outcome analysis of Zenker's diverticulectomy and criopharyngeal mytomy. *Head Neck* 1995; 17(5):382–8.

Laryngeal Framework Surgery (Thyroplasty, Arythenoid Adduction, Injection Laryngoplasty)

Surgical Considerations

Description: Thyroplasty is a surgical technique of medializing a paralyzed vocal fold via placement of an implant inserted through the cartilage of the thyroid ala. Under local anesthesia with intravenous sedation, a skin incision is made at the level of the larynx and the thyroid cartilage exposed. Using a small saw, drill bit, or knife, a window is cut in the cartilage to the level of the inner perichondrium. Lateral pressure is then applied to the paralyzed side to gauge the amount of medialization necessary to improve phonation. Because the shape and size of the implant is created based on the location and degree of medialization needed to improve the voice, it is important for the patient to be awake and able to phonate during the procedure. Often the patient is kept in a state of deeper sedation in the beginning of the case and then is lightened as the case proceeds to allow the patient to be responsive and interactive with the surgeon. This can be a challenge for the anesthesiologist to strike a happy medium between patient comfort and coherence. After the desired degree of medialization is obtained, the implant is secured in place and the wound closed over a drain.

Description: Arytenoid adduction is often performed in conjunction with thyroplasty. This involves placement of a suture around the muscular process of the arytenoid cartilage which, when tightened, causes posteromedial rotation of the vocal process and adduction of the vocal fold. Usually the technique is employed when there is a persistent gap between the vocal folds posteriorly.

Description: Injection laryngoplasty refers to medialization of a paralyzed vocal fold by means of injection, whether percutaneous or endoscopic. Its minimally invasive nature is its chief advantage over thyroplasty or arytenoid adduction. However, the longevity of the injected material as well as its side effect profile are major determinants as to whether or not this procedure should be considered. Traditionally, Teflon has been the injectable material of choice. However, because of the potential for a foreign body reaction, Teflon has been largely replaced by more biocompatible materials, such as collagen, acellular human dermis, fat, gelfoam, and calcium hydroxylapatite to name a few. Because of the low viscosity of material such as collagen, many patients are candidates for percutaneous injection, which can be performed in the office or procedure room under simple topical anesthetic. The patient is seated upright and the nasal cavity topically anesthetized with lidocaine 2% and neosynephrine. A fiberoptic rhinolaryngoscope attached to a camera and television monitor is then passed transnasally to the level of the glottis. Through a 25- or 27-gauge needle, the desired material is injected either transcartilagenously, through the cricothyroid membrane, or under the thyroid ala into the paraglottic space. Observing on the monitor, the material is injected until the desired degree of medialization is obtained. This is well tolerated by patients with minimal pain. Airway obstruction or bleeding are exceedingly rare.

For those who request or require injection under GETA a 5.0 microlaryngeal tube is desirable. Jet ventilation and apneic techniques can also be used. An operating laryngoscope is advanced to the level of the glottis and suspended from a Mayo stand. The paryalyzed vocal fold is then injected, usually at the mid and posterior aspects, until adequate medialization is seen. Usually this entails slight overcorrection such that the medialized fold will now be *(Print pagebreak 194)* slightly across midline. Hemostasis if needed is usually obtained with epinephrine-soaked pledgets placed directly on the vocal fold. The scope is then withdrawn and the procedure terminated.

It is important for the anesthesiologist to be aware if a patient has undergone a prior medialization procedure. This is not a contraindication to orotracheal intubation for subsequent procedures requiring GETA. However, traumatic intubation or the use of a tube larger than 6 mm may cause trauma to the adducted fold. A laceration of the vocal fold can potentially expose or dislodge a thyroplasty implant, making it more likely to become infected and potentially extrude.

Usual preop diagnosis: Vocal fold paralysis.

Summary of Procedures

	Thyroplasty	Arytenoid Adduction	Injection Laryngoplasty
Position	Supine		
Special instrumentation	Head and neck set; headlights	–	Dedo operating laryngoscope; laryngeal injection needles; Jet ventilation setup.
Unique considerations	Overmedialization of the vocal fold can potentially cause stridor and dyspnea; Coordination between the surgeon and anesthesiologists is essential to time lightening	If GETA is requested, intubate with 5.0 microlaryngeal tube.	Overmedialization of the vocal fold can potentially cause stridor and dyspnea.

	of anesthesia; ETT stimulation can cause coughing.		
Antibiotics	Cefazolin 1gm		
Surgical Time	1–2 h		30 min
EBL	< 10 mL	10–20 mL	Minimal
Postop care	Decadron intravenously for 24 h; racemic epinephrine; cool mist.		racemic epinephrine; cool mist as needed
Mortality	Rare		
Morbidity	Need for revision: 10–20% Transient dyspnea or laryngospasm Infection: < 5% Airway obstruction requiring tracheostomy: 1% Extrusion: rare		Need for repeat injection common 5–10% rare
Pain score	3–4	4–5	1–2

Patient Population Characteristics

Age range	18 and over
Male:Female	1:1
Incidence	Common
Etiology	Surgical trauma to recurrent laryngeal nerve; cancer; trauma; idiopathic
Associated conditions	Cancer; coronary artery disease; lung disease; tumors of skull base

(Print pagebreak 195)

Suggested Readings

1. Cotter CS, Avidano MA, Crary MA, et al: Laryngeal complications after type 1 thyroplasty. *Otolaryngol Head Neck Surg* 1995; 113(6): 671–3.

2. Damrose EJ, Berke GS: Advances in the management of glottic insufficiency. *Curr Opin Otolaryngol Head Neck Surg* 2003; 11 (6):480–4.

3. Flint PW, Purcell LL, Cummings CW: Pathophysiology and indications for medialization thyroplasty in patients with dysphagia and aspiration. *Otolaryngol Head Neck Surg* 1997; 116(3):349–54.

4. Herman C: Medialization thyroplasty for unilateral vocal cord paralysis. *AORN J* 2002; 75(3):512–22.

5. Isshiki N, Morita H, Okamura H, et al: Thyroplasty as a new phonosurgical technique. *Acta Otolaryngol* 1974; 78(5–6): 451–7.

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7. Isshiki N, Tsuji DH, Yamamoto Y, et al: Midline lateralization thyroplasty for adductor spasmodic dysphonia. *Ann Otol Rhinol Laryngol* 2000; 109(2):187–93.

8. Pou AM, Carrau RL, Eibling DE et al: Laryngeal framework surgery for the management f aspiration in high vagal lesions. *Am J Otolaryngol* 1998; 19(1):1–7.

9. Weinman EC, Maragos NE: Airway compromise in thyroplasty surgery. *Laryngoscope* 2000; 110(7):1082–5.

Anesthetic Considerations

Preoperative

The laryngeal framework surgery (LFS) is the surgery of choice for dysphonias resulting from incomplete glottic closure or inadequate vocal fold tension. With thyroplasty, direct surgery on the vocal folds is avoided, eliminating the possibility of scarring and voice aggravation. Type I (medialization) thyroplasty is most commonly performed for the unilateral VC paralysis or bowing (in elderly patients), and involves placement of a small silicon implant within the larynx on the affected side.

Airway	No airway problems are usually encountered in these patients
Cardiovascular	Elderly patients may present with advanced cerebrovascular, cardiovascular, or pulmonary disease. Preop pulmonary aspiration due to glottic incompetence is uncommon, but may be seen when the VC paralysis is of central origin, affecting both motor and sensory components of the VC innervation.
Tests	EKG; other tests as indicated from H&P
Laboratory	Tests, as indicated from H&P
Premedication	Standard premedication with iv midazolam can frequently be reduced or avoided, especially in the elderly.

Intraoperative

Anesthetic technique: Most commonly, thyroplasty is performed under MAC, which allows the surgeon to achieve optimal improvement in the patient's voice quality (sometimes facilitated by visualization of the VC movement through a nasally introduced flexible fiberoptic endoscope) before locking the laryngeal implant in place. It can also be performed under GA, when the concomitant use of the LMA and flexible fiberoptic bronchoscope allows a real-time assessment of VC positioning. **Arythenoid adduction** and **injection laryngoplasty** are usually performed under GETA with the use of a small (5.0 mm ID) MLT ETT.

The essential surgical requirements for **thyroplasty** performed under MAC include: patient immobility for an effective injection of a local anesthetic; alternating levels of MAC sedation, depending on the part of the surgery (deep level of sedation during the surgical approach to the cartilage, light for the implant placement, and deep again during the surgical closure); absence of straining/bucking/coughing during the implant placement and manipulation on the thyroid cartilage necessitates the use of iv opioids.

GETA for **arythenoid adduction** and **injection laryngoplasty** requires full muscle relaxation with quick return of protective airway reflexes and smooth emergence from anesthesia.

When providing MAC for thyroplasty, a quick patient transition to the “light” state for the implant placement is required. A combination of a small dose (1–2 mcg/kg) of iv fentanyl with the iv propofol infusion, or iv midazolam with iv remifentanil infusion (typically, 0.05–0.1 mcg/kg/min to avoid severe respiratory depression), will achieve *(Print pagebreak 196)* the stated objective. For a thyroplasty performed under GA, as well as for the GETA employed for a **arythenoid adduction** and **injection laryngoplasty** surgery, the use of TIVA (see Introduction, Anesthesiologist's Perspectives, p. 174) has been shown to be highly beneficial. The **injection laryngoplasty** procedures can be very short, and, if properly coordinated with the surgeon, can occasionally be performed without tracheal intubation, using an apnea technique following IV induction, administration of a relatively large dose of succinylcholine (1.5–2 mg/kg) and brief mask hyperventilation with $FiO_2 = 1.0$.

Blood and fluid Requirements	IV: 20 ga × 1 LR @ 2 cc/kg/h	EBL is minimal during all the LFS procedures
Monitoring	Standard monitors (p. B-1)	Even in patients with pre-existing significant CV disease, A-line monitoring

	± arterial line	is usually not necessary
Positioning	Table may be turned 90–180° and pad pressure points eyes	To prevent claustrophobia, inform the patient presenting for the thyroplasty under MAC, that his/her face will be partially covered with surgical towels.
Complications	Overmedialization stridor and dysphonia	Can be quickly corrected by the surgeon

Postoperative

Complications	Wound hematoma. Airway obstruction Stridor Extrusion of the prosthesis
Pain management	Short-acting parenteral opioids (p. C-1) are usually sufficient

Suggested Readings

1. Grundler S, Stacey MR: Thyroplasty under general anesthesia using a laryngeal mask airway and fibreoptic bronchoscope. *Can J Anaesth* 1999; 46(5Pt1):460–3.

2. Hoffman H, McCabe D, McCulloch T, et al: Laryngeal collagen injection as an adjunct to medialization laryngoplasty. *Laryngoscope* 2002; 112(8 Pt1):1407–13.

3. LinksOdland RM, Wigley T, Rice R: Management of unilateral vocal fold paralysis. *Am Surg* 1995; 61:438–43.

4. Lundy DS, Casiano RR, Xue JW: Can maximum phonation time predict voice outcome after thyroplasty type I? *Laryngoscope* 2004; 114:1447–54.

5. Razzaq I, Wooldridge W: A series of thyroplasty cases under general anaesthesia. Br J Anaesth 2000;85:547–9.

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Remacle M, Lawson G, Jamart J, et al: Treatment of vocal fold immobility by injectable homologous collagen: short-term results. *Eur Arch Otorhinolaryngol* 2006; 263:205–9.

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Tracheal and Cricotracheal Resection

Surgical Considerations

Description: Prolonged endotracheal intubation and complications from tracheotomy account for most cases of subglottic or tracheal stenosis. Wegener's disease commonly affects the subglottic airway and secondary dyspnea may be the first presenting sign of the disease. In females in the 4th to 6th decades of life, subglottic stenosis can be idiopathic. Whatever the etiology, subglottic and tracheal stenosis can be a major source of morbidity for afflicted *(Print pagebreak 197)* patients, resulting in dyspnea, dysphonia, and tracheostomy dependence. In selected individuals, resection of the stenotic region with primary repair can often produced marked and sustained relief of symptoms in a single stage procedure, often without need for a temporary tracheostomy.

Tracheal resection is the treatment of choice in patients with isolated tracheal stenosis. Up to four to five rings of cartilage can be resected, more if releasing maneuvers to mobilize the larynx and intrathoracic trachea are performed. Induction of anesthesia is simplest in patients with pre-existing tracheostomies. For those patients who present without a tracheostomy, a tracheostomy under

local anesthesia can be performed at or immediately below the stenotic segment. If possible, it is preferable to dilate the stenosis and proceed to endotracheal intubation so as to avoid further injury to the trachea with a fresh tracheotomy. With the patient in the supine position, a transverse cervical incision is made. The thyroid isthmus is divided and separated from the cervical trachea. Careful blunt dissection on the lateral aspects of the diseased segment is performed to avoid injury to the recurrent laryngeal nerves. A vertical incision is made along the face of the stenotic segment until a healthy complete ring of cartilage is identified above and below the stenotic segment. The anesthesiologist withdraws the ETT up into the subglottis and the diseased segment of trachea is resected. At this time, the surgeon may intubate the distal segment of trachea in order to afford better access to the superior aspect of the diseased segment. In this case, the breathing circuit will need to be switched from the orotracheal tube to the distal tube. The distal trachea can be more easily mobilized superiorly following blunt finger dissection along the anterior tracheal wall into the mediastinum. The orotracheal tube is then advanced inferiorly into the distal healthy segment. The healthy distal and proximal segments of trachea are then reanastomosed over the ETT using interrupted sutures. The wound is closed and a drain placed. If the patient is to remain intubated overnight, it is important to ensure that the cuff of the endotracheal tube remains inferior to the suture line so as not to put tension on the repair. If the patient is to be extubated in the OR, care should be taken to minimize coughing or bucking so as not to rupture the repair site. Endoscopy can be performed prior to transport from the operating room to ensure that at least one vocal fold is mobile. If neither vocal fold is mobile, a bilateral recurrent laryngeal nerve injury should be suspected and a tracheostomy performed. Regardless of whether or not the patient is extubated immediately or later, fiberoptic laryngoscopy to assess vocal fold motion postop is standard of care. Voice quality is not an adequate assesment of vocal fold function. A paralyzed vocal fold can be midline with complete compensation by the mobile fold and no overt dysphonia. In bilateral vocal fold paralysis, the voice is often normal, and the patient's only symptoms will be dyspnea and stridor.

Cricotracheal resection allows single-stage repair of subglottic or a combined subglottic/tracheal stenosis. The procedure is similar to that of tracheal resection with several caveats. It is important to carefully gauge the relationship of the stenosis to the vocal folds. Stenosis that involves the vocal folds is a contraindication to cricotracheal resection. The anterior arch of the cricoid cartilage is usually resected, along with the subglottic soft tissue component of the stenosis, preserving the cricoid plate. This creates a cradle into which the trachea will slide superiorly. No more than one-third of the inferior aspect of the cricoid plate can be resected. More than this will disrupt the posterior cricoarytenoid muscles and prevent vocal fold abduction during inspiration. As resection proceeds, the ETT will be withdrawn above the glottis. It is helpful at this point to attach an umbilical tape to the distal tip of the ETT to allow the surgeon to assist the anesthesiologist in advancing the tube back through the glottis and into the trachea when the resection is complete. The trachea is sutured to the thyroid cartilage anteriorly and the cricoid ring laterally; the wound is closed; and a drain may be placed. The patient is extubated in the OR and vocal fold mobility checked. Tracheostomy is only required in the setting of bilateral vocal fold paralysis and should otherwise be avoided. As with tracheal resection, a preop assesment of vocal fold motion is critical in planning surgery. If unilateral paralysis is present preop, great care is needed to minimize potential injury to the contralateral recurrent laryngeal nerve.

Usual preop diagnosis: Subglottic stenosis; tracheal stenosis

Summary of Procedures

	Tracheal Resection	Cricotracheal Resection
Position	Supine	Supine
Incision	Transverse cervical	Transverse cervical
Special instrumentation	Major head and neck tray; headlights	
Unique considerations	Intubation may be difficult owing to degree of stenosis; dilation may be required prior to intubation; awake tracheostomy under local anesthesia may be necessary in select cases.	
Antibiotics	Cefazolin 1gm and metronidazole 500 mg; clindamycin 600 mg; vancomycin 1gm; piperacillin/tazobactam 3.375 gm	
Surgical time	3 h	
EBL	50–100 mL	

Postop care	Most patients can be extubated at the conclusion of surgery; coughing and stimulation should be minimized; if significant edema is expected, patients may remain intubated for 24 to 48 h then extubated; patients may require temporary NG tube feedings if laryngeal releasing maneuvers performed; monitoring in ICU setting for airway compromise or subcutaneous emphysema required postop	
Mortality	1–2%	
Morbidity	Restenosis: 10% Vocal cord paralysis: 2–3% Dehiscence: 5% Subcutaneous emphysema: 1–2% Airway edema requiring tracheotomy: 2%	10–15% 3–5% < 5% 1–2% 5%
Pain score	5–6	5–6

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Patient Population Characteristics

Age range	All ages
Male:Female	2:1
Incidence	1% of all patients requiring intubation
Etiology	Prolonged intubation; prior tracheostomy; Wegener's disease; external trauma; neoplasm; radiation; gastroesophageal reflux; idiopathic.
Associated conditions	Atherosclerosis; asthma; gastroesophageal reflux.

Suggested Readings

1. Brown BR: Anaesthesia for ear, nose, throat and maxillofacial procedures. In *International Practice of Anaesthesia*. Prys-Roberts C, Brown BR, eds. Butterworth-Heinemann, Oxford: 1996, 2–9.

2. Chee WK, Benumof JL: Airway fire during tracheostomy: extubation may be contraindicated. *Anesthesiology* 1998; 89:1576–8.

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5. Rogers ML, Nickalls RWD, Brackenbury ET, et al: Airway fire during tracheostomy: prevention strategies for surgeons and anaesthetists. *Ann R Coll Surg Engl* 2001; 83:376–80.

(Print pagebreak 199)

Laryngectomy: Partial and Total

Surgical Considerations

Description: Either radiation, chemoradiation or surgery is commonly employed as primary treatment of laryngeal squamous cell carcinoma. Selected tumors can be removed endoscopically, as reviewed above. Open procedures, which may be primary or following recurrence after irradiation, are designed to fit tumor extent. If at least one cricoarytenoid unit (innervated posterior cricoarytenoid muscle and working cricoarytenoid joint) is uninvolved by tumor, the patient may be a candidate for less than a total laryngectomy.

A **vertical partial laryngectomy** (VPL) involves removal of the true and false vocal cord, and up to one-third of the contralateral same structures including the anterior commissure. The contralateral cricoarytenoid unit is preserved, and reconstruction often includes a pedicled sternohyoid muscle as well as thyroid cartilage perichondrium. Exposure and anesthetic considerations are similar to that of a total laryngectomy (discussed below) other than the fact that a temporary tracheotomy is used in the partial laryngectomy.

A **supraglottic laryngectomy** (Fig. 3-4 and Fig. 3-5) or **anterior horizontal partial laryngectomy** (AHPL) (Fig. 3-6) involves removal of laryngeal structures superior to the true vocal cords. The amount of retained false vocal cord tissue is variable. One or both cricoarytenoid units remain. The resection may include some of the base of tongue. Exposure and anesthetic considerations are the same as for for a VPL, including the need for a temporary tracheotomy.

A **supracricoid laryngectomy** involves removal of the larynx from the cricoid ring to the hyoid bone with preservation of at least one arytenoid. A temporary tracheostomy is required. Cuts are made above the thyroid ala, through the cricothyroid membrane, and anterior to the arytenoid cartilages. The epiglottis may be included in the resection if necessary, depending upon the extent of the tumor. Blunt finger dissection anterior to the trachea into the mediastinum is performed to allow for superior mobilization of the trachea. A cricohyoidopexy, involving the suturing of the cricoid ring to the hyoid bone, is then performed with three heavy sutures. If the epiglottis has been preserved, a cricohyoidoepiglottopexy is performed. The strap muscles are then used to reinforce the closure, and drains are placed.

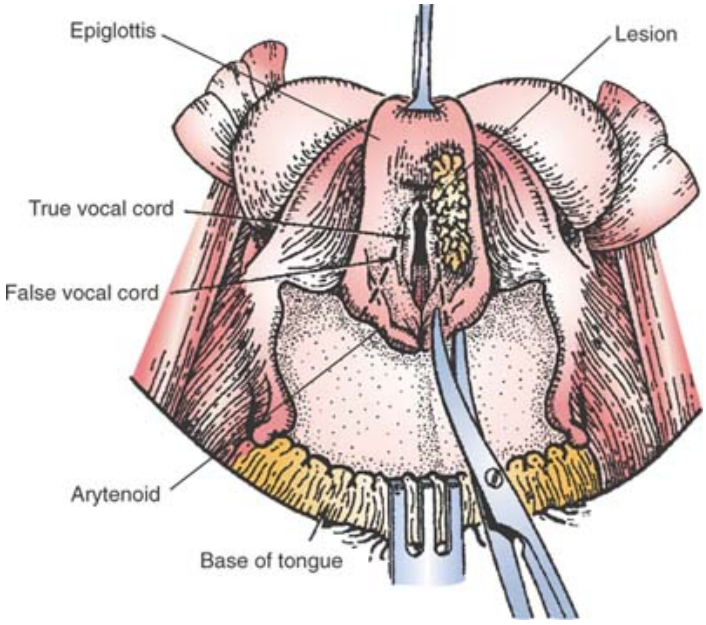

Figure 3-4. The larynx is viewed from the midline, as seen by the surgeon standing at the head of the operating table. Unless the lesion extends posteriorly to the arytenoid, the aryepiglottic fold is transected on each side by placing one blade of the dissecting scissors into the laryngeal ventricle or above the false vocal cord and the other blade in the pyriform sinus. The arytenoid on one side can be resected if the tumor extends posteriorly to involve this structure. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

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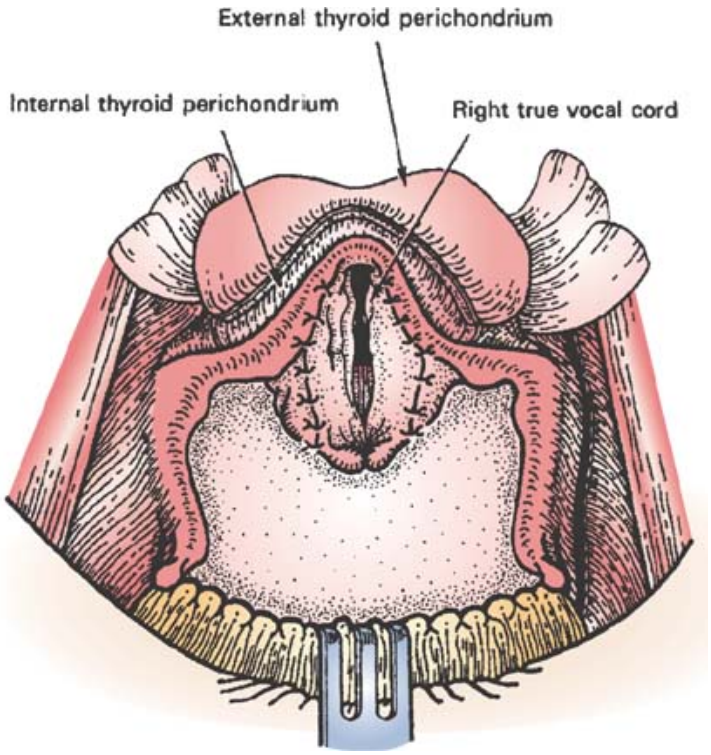

Figure 3-5. The repair following supraglottic partial laryngectomy begins by carefully approximating the margin of the mucous membrane of the pyriform sinus to the lateral margin of the laryngeal ventricle, or to the margin of resection above the false vocal cord. There is usually some distortion of the true vocal cord when the repair is accomplished, as is shown on the patient's right side. The repair is continued anteriorly by placing multiple interrupted 3-0 chromic catgut sutures. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

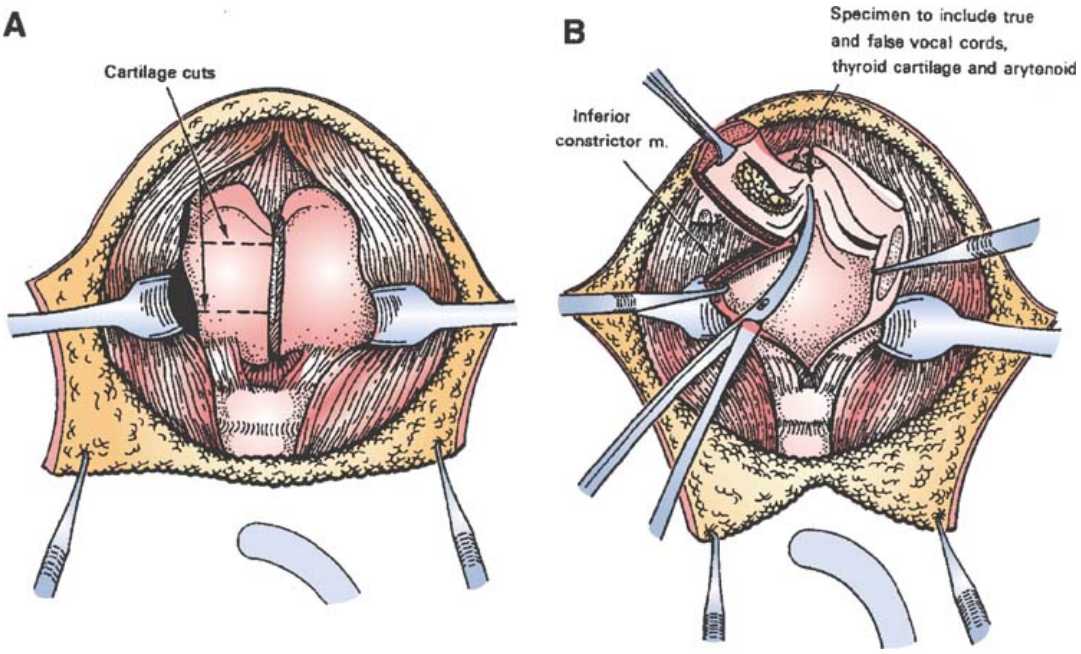

Figure 3-6. (A) Horizontal incisions, corresponding to the mucosal incision, are made through the thyroid lamina. **(B)** The specimen—including true and false vocal cords, the arytenoid, and a portion of the thyroid lamina—is resected en bloc. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

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A **total laryngectomy (TL)** involves the resection of the entire larynx, and can be done via an incision about 8 cm long, low in the midline neck. An apron incision is often used instead, or the low incision is extended toward a mastoid tip in order to provide

exposure for a neck dissection if indicated. The thyroid gland is often preserved, pedicled on its superior and inferior vasculature after dividing the isthmus; but if indicated a partial thyroidectomy may be included. The thyoid is resected with the specimen and the pharynx closed primarily. A nasogastric tube is used for nutrition for all open laryngeal tumor surgery, unless the surgeon opts to provide nutrition via a tracheoesphageal puncture, discussed below. As the remaining trachea is sutured to the anterior skin in a true tracheostoma, no tracheotomy tube or ETT is required postop unless there is marked stomal edema or mechanical ventilaton is required, which is not common.

If a TL is performed, a **tracheoesphageal puncture** (TEP) may be performed simultaneously. This involves the creation of a tract or fistula between the trachea and the esophagus for placement of a voicing prosthesis (a one-way valve that allows airflow from the trachea into the pharynx for alaryngeal speech). The voicing prosthesis may be placed at the time of the laryngectomy or as a secondary procedure at a later date. If performed secondarily, it is placed using the technique of rigid esophagoscopy (see previous section). If TEP is performed at the time of laryngectomy, the valve can be placed simultaneously. Some surgeons prefer to place a red rubber catheter instead, which can allow the patient to be fed via this route in lieu of a nasogastric or gastrostomy tube. After the patient is deemed fit to start oral intake, the catheter can be exchanged secondarily for the voice prosthesis. If a rubber catheter is used, the tube will protrude from the stoma, and care must be taken not to dislodge it during suctioning or while removing or replacing the laryngectomy tube if one is temporarily used during the period of postop edema.

A TL can be extended to include part of the hypopharyx or oropharynx as dictated by tumor extent. If flap reconstruction is necessary because of the extent of the tumor, options include use of a pectoralis major myocutaneous flap or a free flap, such as a radial free flap, to reconstruct less than a circumferential defect. If a circumferential defect following resection exists (e.g. after resection of the superior cervical esophagus and the larynx), options for reconstruction include use of a laparascopically harvested jejunal free flap, gastric pullup, or a tubed radial free flap reinforced with a pectoralis major myogenous flap.

Postop care: Inpatient admission for 5–10 d; monitored bed or ICU for tracheostomy care or following more extensive pharyngeal reconstruction; a cuffed trachestomy tube (and a temporary tracheotomy) will usually be required for partial laryngectomy patients or if the patient will require postop mechanical ventilation. A shorter tracheostomy tube following a TL will be needed if there is significant peristomal edema or if mechanical ventilation is required. General and drain management is similar to a neck dissection.

Usual preop diagnosis: Cancer of larynx; intractable aspiration with resultant pneumonia unresponsive to other techniques.

Summary of Procedures

	Total or Partial	Pharyngolaryngectomy
Position	Supine, head extended	
Special instrumentation	Major head/neck set; headlights	
Unique considerations	Laryngeal tumors may distort airway. Fiberoptic intubation or other management of the difficult airway should be considered. May be combined with neck dissection.	
Antibiotics	Cefazolin 1 gm and metronidazole 500 mg; clindamycin 600 mg	
Surgical time	2–4 h; 4–8 if neck dissection added	4–8 + h
EBL	50–300 mL With neck dissection: up to 500 mL. Transfusions rarely indicated.	
Postop care	Tracheotomy care, drain management; tube feedings	
Mortality	< 1%	
Morbidity	Fistula formation: 5%: 15–20% if prior irradiation Hematoma: < 4% Infection: < 5% DVT/PE: < 1%	1%
Pain score	4–6	4–7

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Patient Population Characteristics

Age range	40–80, occasionally older and younger
Male:Female	3:1
Incidence	Common
Etiology	Smoking; alcohol
Associated conditions	COPD; atherosclerosis; diabetes

Anesthetic Considerations

Preoperative

See preop considerations for Neck Dissection, p. 216.

Airway	If a stridor at rest is pressent, its severity must be carefully evaluated. Patients with symptoms and signs of severe obstruction (complaints of difficulty breathing, nocturnal symptoms, sleeping upright, use of accessory muscles on inspiration at rest) will likely be difficult to ventilate and intubate.
Respiratory	Patients with severe stridor may manifest baseline hypoxemia (with or without hypercarbia) 2° ↓ airway diameter and atelectases caused by ↓ ability to effectively handle secretions.

Intraoperative

Anesthetic technique: GETA. Although tracheostomy is universally performed in these patients, smooth emergence is still important 2° delicate suture lines. Full muscle relaxation is essential. Moderate ↓ BP (see Introduction, p. 174) is desirable, but may be limited by concomitant cardiovascular disease.

Induction	There is no universal recipe for management of the partially obstructed airway. One approach is outlined below. If stridor is **absent** and airway assessment is normal, standard induction followed by DL is appropriate. In patients with pre-existing stridor, attempts to secure an airway while awake (including awake FOI) may precipitate complete upper airway obstruction. In patients with **moderate stridor,** in whom intubation is considered possible (larynx visible on preop nasal endoscopy, tumor not too large, absence of gross anatomical distortion, absence of fixed hemilarynx), inhalational induction, followed by gentle DL or asleep FOI, is the technique of choice. The ENT surgeon should be present in the OR, ready to perform rigid bronchoscopy or emergent tracheostomy. If the airway cannot be secured after 2–3 attempts, tracheostomy must be performed under controlled conditions with the patient breathing spontaneously. In patients with **severe stridor** and low probability of successful intubation, a preliminary tracheostomy must be performed under local anesthesia without any sedation. Although in the majority of patients presenting for laryngectomy the location of tumor is submucosal, exophytic tumor growth may be present (e.g., VC). In this circumstance, direct visualization of the passage of the ETT through the VC (DL or video laryngoscopy) is essential to eliminate or greatly diminish the risk

	of tumor fragmentation and bleeding. Other anesthetic considerations are similar to those in Neck Dissection, p. 216.
Maintenance	See Anesthetic Considerations for Neck Dissection, p. 216. After tracheostomy, a sterile reinforced ETT (6.0–7.0 mm ID) is inserted by the surgeon and connected to a sterile anesthesia breathing circuit. Proper ETT placement should be confirmed by presence of $ETCO_2$, equal bilateral breath sounds and normal airway compliance. Following tracheostomy, ↑ FiO_2 to at least 50%, because the surgeon will continue working around the ETT, occasionally removing it from the patient's trachea for suture application. The position of the ETT in the tracheostoma should be monitored closely to prevent the ETT from slipping into the right mainstem bronchus.
Emergence	See Anesthetic Considerations for Neck Dissection, p. 216.

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For further discussion, see Intraoperative Considerations for Neck Dissections, p. 216.

Postoperative

See Postop Considerations for Neck Dissections, p. 218.

Suggested Readings

1. Bonner S, Taylor M: Airway obstruction in head and neck surgery. *Anaesthesia* 2000; 55:290–1.

2. Donlon JV, Feldman MA: Anesthesia for eye, ear, nose, and throat surgery. In *Miller's Anesthesia*, 6th edition. Miller RD, ed. Elsevier/Churchhill Livingstone, Philadelphia: 2005, 2527–49.

3. Dougherty TB, Nguyen DT: Anesthetic management of the patient scheduled for head and neck cancer surgery. *J Clin Anesth* 1994; 6:74–82.

4. Mason RA, Fielder CP: The obstructed airway in head and neck surgery. *Anaesthesia* 1999; 54:625–8.

5. See Suggested Readings for Neck Dissection, p. 218.

Tonsillectomy and/or Adenoidectomy

Surgical Considerations

Description: The dissection for **tonsillectomy** is carried out with the patient supine, shoulders elevated on a small pillow (Fig. 3-7). A mouth gag is inserted; and, if an **adenoidectomy** is being done concurrently, adenoids are removed first with a curette, and the nasopharynx packed. The tonsillectomy is accomplished by firmly grasping the upper pole of the tonsil and drawing it medially, allowing a mucosal incision to be made over the anterior faucial pillar. The tonsil is dissected from its bed and removed. A snare may be used to snip the dissected tonsil off at the lower pole. Hemostasis is secured with gauze packs and the use of electrocautery. Packs are removed from the nasopharynx and tonsillar beds before extubation. Tonsillectomy may be combined with **palatopharyngoplasty** in cases of obstructive sleep apnea (OSA) or stertorous breathing (see p. 249).

Variant procedure or approaches: Guillotine technique (rarely used)

Usual preop diagnosis: Chronic tonsillitis and/or adenoiditis (most common); OSA; asymmetric enlargement of tonsils (to r/o

cancer); nasal airway obstruction; snoring; peritonsillar abscess.

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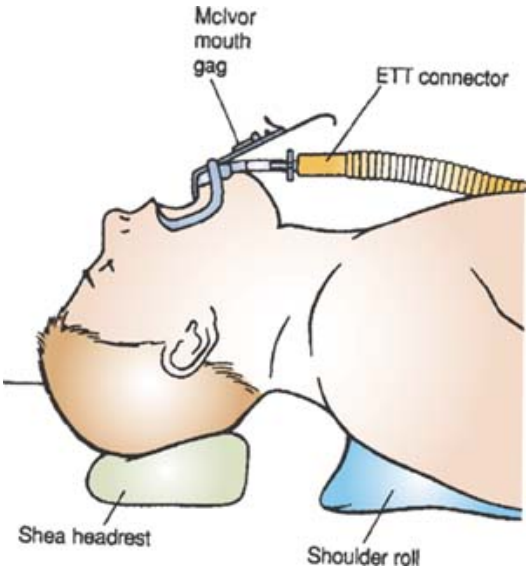

Figure 3-7. The "Rose" position for tonsillectomy.

Summary of Procedures

Position	"Rose" (supine, shoulder roll, head extended); surgeon at head of table (turned 90–180°)
Incision	Intraoral mucosal
Special instrumentation	Mouth gag (McIvor)
Unique considerations	Use of armored ETT prevents compression of tube by mouth gag. Tube should be secured to lower lip in midline.
Antibiotics	Amoxicillin po
Surgical time	30–60 min
Closing considerations	If patient has OSA, a heightened sensitivity to narcotics and sedatives may make emergence more difficult. Avoid hypercapnia on emergence to prevent vasodilation and resultant bleeding. Awake extubation will provide maximum airway protection.
EBL	25–200 mL. Monitor suction bottle contents and irrigation as an indication of blood loss.
Postop care	Lateral position; head down; gentle suctioning
Mortality	Rare
Morbidity	Bleeding: 4% Infection: 4% Delayed bleeding: 3.2% Aspiration: Rare Tooth damage: Rare
Pain score	4–6

Patient Population Characteristics

Age range	2+ yr
Male:Female	1:1

Incidence	50 per 10,000 children in the United States
Etiology	Chronic infection; OSA (most common indication); peritonsillar abscess; snoring; cancer
Associated conditions	Nonspecific

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Anesthetic Considerations

Preoperative

Most patients are young and otherwise healthy; however, a subset of both pediatric and adult patients may present with Sx of OSA or URI. For many children, this is their first anesthetic; therefore, it is imperative to family Hx for anesthetic problems. Most adult and pediatric patients are discharged from the hospital on the day of surgery.

Airway	In patients with a Hx of snoring or OSA, the probability of difficult mask ventilation and/or intubation may be high, 2° airway characteristics peculiar to these patients (see Anesthesia for Reconstructive Surgery for Sleep-Disordered Breathing, p. 255). In children with short-stature syndrome, including achondroplastic dwarfism and selected cases of Down syndrome, atlantoaxial subluxation and stenosis of the spinal canal may be present, and neck extension in these patients should be avoided.
Respiratory	In patients presenting with Sx of acute URI (purulent sputum or nasal secretions, fever, etc.), the general recommendation is to postpone any elective procedure until symptoms have abated, usually within 7–14 d. **Tests:** As indicated from H&P.
Dental	The presence of chipped, loose, or broken teeth should be documented preop and the patient (or parents, if appropriate) should be informed that there is a possibility of further tooth damage/dislodgement by the mouth gag applied by the surgeon.
Cardiovascular	Rarely, chronic airway obstruction (e.g., OSA) with hypoxemia may → pulmonary HTN and right heart failure. Patients with Down syndrome may have concomitant CHD. **Tests:** As indicated from H&P.
Hematologic	for recent aspirin use and Hx of excessive bleeding following minor trauma or tooth extraction.
Laboratory	CBC; other tests as indicated from H&P.
Premedication	Sedative premedication is routine (see p. B-1), but should be avoided in OSA patients and patients with Sx of upper airway obstruction. Some surgeons request preop administration of an antisialagogue to achieve a dry surgical field.

Intraoperative

Anesthetic technique: Balanced GETA is most commonly used in adults. (For pediatric anesthetic considerations, see p. 943.) Adequate muscle relaxation is an essential surgical requirement: it facilitates surgical exposure and prevents patient from swallowing. Continuous control and protection of the airway is another major objective, along with smooth emergence from anesthesia and prevention of early postop laryngospasm. Specific airway considerations include the possibility of difficult mask ventilation and/or difficult intubation 2° large tonsils and ↓ pharyngeal space, as well as the possibility of intraop obstruction of the ETT with the mouth gag placed by the surgeon.

An **intravenous induction** with propofol (2 mg/kg) and fentanyl (2–3 mcg/kg) is suitable for the majority of patients. If difficulty with mask ventilation is encountered, an oral airway is preferred to a nasal airway, 2° the possibility of trauma to the

	hypertrophied adenoid tissue and the resultant brisk bleeding. Patients with peritonsillar abscess may have trismus, which usually resolves after induction of anesthesia and administration of a muscle relaxant.
Induction	Great care should be exercised with introduction and manipulation of laryngoscope blade to avoid bleeding 2° inadvertent trauma to the enlarged tonsils, and to prevent soiling of the airway in patients with a peritonsillar abscess. The lightwand technique of tracheal intubation should be used with caution or avoided in these patients. The use of a small (6.0 mm ID) reinforced ETT is preferred over an oral RAE ETT, because of better resistance to kinking/obstruction by the mouth gag. The use of a FLMA can safely protect the airway during adenotonsillectomy and reduce the incidence of postextubation complications in adults and children. Its use for this procedure, however, has not become popular in the United States.
Maintenance	Opening of a mouth gag and the tonsillectomy itself constitute powerful noxious stimuli; therefore, an adequate depth of anesthesia must be maintained. It is essential to verify the ETT position before and after Boyle-Davis or McIvor mouth gag application (e.g., chest movement, bilateral and equal breath sounds, and nomal PIP): the ETT may be obstructed, dislodged, kinked, or inadvertently advanced into a mainstem bronchus, or the patient's trachea can be prematurely extubated when the mouth gag is repositioned/removed. Moderate ↓ BP is desirable but not obligatory; and judicious use of vasoactive drugs (see Introduction, p. 174) is preferred to deep levels of anesthesia 2° short duration of the procedure. Low-dose remifentanil infusion (see Introduction, p. 174) as part of either balanced or TIVA technique will provide superior hemodynamic stability and facilitate smooth emergence from anesthesia. For a balanced inhalational technique, desflurane and sevoflurane are the preferred agents for these short surgical procedures. Isoflurane may be favored in pediatric patients 2° ↓ agitation on emergence. The mouth gag may be repositioned several times during the procedure and is removed only at the end of the case. Vigorous patient movement while the mouth gag is hooked on the Mayo stand may cause C-spine injury; thus, neuromuscular blockade should usually be maintained until the end of the surgery. Prevention of PONV is of major importance. If a throat pack is not used by the surgeon, the patient's stomach should be suctioned at the end of the case, and further gastric emptying may be facilitated by administration of metoclopromide (1–2 mg/kg up to 20 mg iv). Administration of 5-HT_3blockers (e.g., ondansetron 0.1 mg/kg up to 4 mg iv), with or without steroids (e.g., dexamethasone 4–10 mg iv), will usually provide adequate antiemetic prophylaxis.
Emergence	Removal of a throat pack (if used by the surgeon) should be verified before extubation. Care must be exercised while suctioning the oropharynx to avoid bleeding. The use of the rubber-tipped vs. Yankauer tip suction catheter may be preferred. Extubation should be smooth and performed after the patient is able to follow commands, because this usually signifies return of protective airway reflexes. If extubation is to be performed at deeper levels of anesthesia (e.g., in small children), the patient should be placed in the lateral decubitus, head-down position ("tonsillar position") to protect the airway from soiling 2° postop bleeding or aspiration of gastric contents. The patient should remain in this position until fully awake. This method of extubation is time- and labor-consuming, requires adequate depth of anesthesia to prevent postextubation laryngospasm, and does not prevent postextubation upper airway obstruction. Careful attention is required to protect patient's pressure points and to prevent the patient from rolling supine. Furthermore, with the head-down position, venous pressure in the surgical wound is increased with the possibility of provoking postop bleeding. This method of extubation cannot be advocated for routine use in adults.
Blood and fluid requirements	IV: 18 ga × 1 (adult) 20 ga × 1 (child) NS/LR @ 4–6 mL/kg/h (adult)	Blood loss is typically minimal. Adequate hydration should continue in the immediate postop period.
Monitoring	Standard monitors (p. B-1)	
Positioning	and pad pressure points. eyes.	See Anesthetic Considerations for Panendoscopy, p. 180.

		ETTs of different sizes should be readily available.
Complications	ETT obstruction dislodgement Bleeding	Blood loss sometimes may be difficult to assess 2° drainage into stomach, especially if a throat pack is not used. Careful observation of suction canisters and close communication with the surgeon are essential.

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Postoperative

		Manifested by immediate symptoms of upper airway obstruction. Under direct laryngoscopy, remove pack with Magill forceps.
	Retention of throat pack	A relatively common complication, particularly in the pediatric population. Rx: 100% O_2via mask ventilation with jaw thrust and CPAP. Rapid-sequence induction (RSI) and direct laryngoscopy/intubation for persistent laryngospasm.
	Laryngospasm	
Complications	Bleeding tonsil	Bleeding usually occurs at a slow pace; large volumes of blood may be swallowed and hypovolemia may occur before any bleeding is detected. Frequent swallowing should alert to the possibility of ongoing hemorrhage. ET intubation (RSI) may prove difficult due to poor visualization secondary to bleeding (effective suction must always be available) and upper airway edema. (See Pediatric section on Anesthesia for Tonsillectomy, p. 943.)
	Postobstructive (negative pressure) pulmonary edema (POPE)	POPE is a rare complication; however, it may occur in patients with pre-existing symptoms of severe upper airway obstruction. Although most cases resolve spontaneously, some patients may require reintubation and postop ventilatory support.
Pain management	See p. C-1	Adult tonsillectomy is a painful procedure, however, most patients are discharged home unless unable to sustain PO intake. Fentanyl is the preferred PACU drug, but the addition of morphine or Dilaudid may be necessary in some patients.
Tests	Hct	If blood loss is suspected

Suggested Readings

1. Brimacombe JR, Keller C, Gunkel AR, et al: The influence of the tonsilar gag on efficacy of seal, anatomic position, airway patency, and airway protection with the flexible laryngeal mask airway: a randomized, cross-over study on fresh adult cadavers. *Anesth Analg* 1999; 89:181–6.

2. Brown BR: Anaesthesia for ear, nose, throat and maxillofacial procedures. In *International Practice of Anaesthesia*. Prys-Roberts C, Brown BR, eds. Butterworth-Heinemann, Oxford: 1996, 2–9.

3. Davis L, Cook-Sather SD, Schreiner MS: Lighted stylet tracheal intubation: a review. *Anesth Analg* 2000; 90:745–56.

4. Dougherty TB: The difficult airway in conventional head and neck surgery. In Airway Management: Principles and Practice. Benumof JL, ed. Mosby, St. Louis: 1996, 686–97.

5. Ebert TJ, Robinson BJ, Uhrich TD, et al: Recovery from sevoflurane anesthesia. A comparison to isoflurane and propofol anesthesia. *Anesthesiology* 1998; 89:1524–31.

6. Sunkhani R, Pappas AL, Lurie J, et al: Ondansetron and dolasetron provide equivalent postoperative vomiting control after ambulatory tonsillectomy in dexamethasone-pretreated children. *Anesth Analg* 2002; 95:1230–5.

7. Webster AC, Morley-Forster PK, Dain S, et al: Anaesthesia for adenotonsillectomy: a comparison between tracheal intubation and the armored laryngeal mask airway. *Can J Anesth* 1993; 40:1171–7.

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Glossectomy

Surgical Considerations

Description: Glossectomy, either **partial** or **total,** is performed for neoplastic lesions of the tongue. During this procedure, nasal intubation is helpful, but not mandatory. Complete muscle relaxation is necessary. Additionally, a drying agent, such as scopolamine or glycopyrrolate, helps reduce oral secretions and facilitates surgery. A side-biting or Dingman mouth gag is used to gain adequate surgical exposure. The lesion is resected with electrocautery and usually can be closed primarily. Depending on the extent of resection, and location on the tongue, a **tracheostomy** may be indicated; or oral intubation alone may suffice for a period of 24–48 h. If neither is done, a short course of steroids helps reduce the lingual edema. A NG tube is placed for postop feeding. A **total glossectomy** is performed in similar fashion, but frequently is combined with a **laryngectomy** because of ensuing aspiration.

Variant procedure or approaches: Glossectomy can be done with a **neck dissection** or **mandibulectomy** and (on occasion) also can be combined with a **total laryngectomy.**

Usual preop diagnosis: Neoplastic disease of the tongue or adjacent structures (e.g., alveolus, floor of mouth) with involvement of the tongue.

Summary of Procedures

	Partial	Total
Position	Supine	
Incision	Intraoral	+ suprahyoid approach/neck approach
Special instrumentation	Dingman mouth gag	
Unique considerations	Hypotensive anesthesia Nasal intubation Postop tracheostomy Steroids, if tracheostomy not performed.	(required)
Antibiotics	Cefazolin 1 g, metronidazole 500 mg	
Surgical time	30 min–1 h	2–4 h
Closing considerations	Usually primary closure. May keep patient intubated 24–48 h if minimal	Flap repair required; laryngeal suspension usually required.

	tongue edema expected.	Tracheostomy mandatory postop.
EBL	50–100 mL	200–400 mL
Postop care	Intubated 24–48 h	Tracheostomy care
Mortality	< 1%	
Morbidity	Bleeding Infection Aspiration	Aspiration Bleeding Infection
Pain score	1–2	2–4

Patient Population Characteristics

Age range	Adults
Male:Female	3:1
Incidence	Uncommon
Etiology	Neoplasia
Associated conditions	Nonspecific

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Anesthetic Considerations

Preoperative

For preop considerations, see Preoperative considerations for Neck Dissection, p. 255.

Airway	Thorough airway assessment is mandatory. Nasal intubation may or may not be required, depending on location of tumor (side vs base of tongue) and surgeon's preference (inquire preop).
Premedication	Standard. (see p. B-1) Preop administration of antisialagogue (e.g., glycopyrrolate 0.2 mg iv) may improve operating conditions—check with the surgeon.

Intraoperative

Anesthetic technique: GETA. Complete muscle relaxation is an essential surgical requirement. For partial glossectomy, smooth extubation is desirable but not mandatory unless skin graft was used for closure (graft hematomas are the primary cause of skin graft failure). Intraop infiltration with a local anesthetic effectively supplements intraop and postop analgesia.

Induction	With a normal airway and submucosal location of tumor on the side of the tongue, standard induction (p. B-2) is appropriate. With mobile, fungating tumors located at the base of the tongue, inhalational induction with subsequent DL or video laryngoscopy may be a safer approach to avoid the risk of the upper airway obstruction. Similar to the considerations for laryngectomy (see Anesthetic Considerations for Laryngectomy, p. 202), direct visualization of the passage of the ETT through the VC (DL or video laryngoscopy) is essential, to eliminate or greatly diminish the risk of tumor fragmentation or bleeding. Large immobile tumors may make ET intubation by conventional means extremely difficult or impossible. Awake nasal FOI may be the technique of choice in these cases.
Maintenance	During a partial glossectomy, surgical closure is quick, and short-acting inhalational agents (desflurane, sevoflurane) may be favored; TIVA may also be employed. ↓ BP (see Introduction, p. 174), although desirable, is not mandatory for partial glossectomy. If tracheostomy is performed as part of the planned procedure, the usual considerations apply (see Anesthetic Considerations for Laryngectomy, p. 202, and Tracheostomy, p.

	187). With prolonged procedures, especially involving tumors located at the base of the tongue, it is prudent to assess the degree of upper airway edema prior to extubation (it may be impossible to reintubate the patient if postextubation upper airway obstruction occurs). Rapid recovery with full return of protective airway reflexes is essential in patients after partial glossectomy.	
Emergence		
Complications	Vagal reflexes: ↓ HR, ↓ BP, mediated by surgical manipulation at the base of the tongue	Rare. Rx: notify surgeon; deepen anesthetic; iv atropine (0.4 mg).

For further discussion, see Intraoperative Considerations for Neck Dissection, p. 216.

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Postoperative

Complications	Postop airway obstruction	May occur 2° ↑ airway edema; emergent tracheostomy may be required. Prophylactic intraop steroids are beneficial.
Pain management	PCA (p. C-3) Parenteral opiates (p. C-2)	

For further discussion, see Neck Dissection, p. 216.

Suggested Readings

1. Donlon JV, Feldman MA: Anesthesia for eye, ear, nose, and throat surgery. In *Miller's Anesthesia*, 6th edition. Miller RD, ed. Elsevier/Churchhill Livingstone, Philadelphia: 2005, 2527–49.

2. Doughrty TB, Nguyen DT: Anesthetic management of the patient scheduled for head and neck cancer surgery. *J Clin Anesth* 1994; 6:74–82.

Maxillectomy and Orbit Exenteration

Surgical Considerations

Description: Transfacial approaches to the paranasal sinuses may also include a maxillectomy or orbital exenteration or both. In an **orbital exenteration** the contents of the orbit are removed, including the eyeball and its attached extraocular muscles posterior toward the conus. This can be done via an incision that is made around the upper and lower eyelashes, occasionally with an extension that includes a limited incision for an external ethmoidectomy; no lateral rhinotomy incision is needed. If the eyelid skin is not involved by tumor it is preserved other than the eyelashes and lid margins. Bradycardia may occur with dissection near the optic nerve.

A **maxillectomy** may be done with the orbit exenteration. If the palate is to be preserved, the incision is the same, because access to the superior maxilla is provided by the exenteration. If the orbit is to be preserved, but the hemipalate is to be resected, then the resection can often be done fully through intraoral incisions. For example, if the anterior palate is to be resected, the approach is essentially the same as the Caldwell-Luc. If the anterior maxilla is to be preserved, but the posterior maxillary alveolar ridge is to be resected (as for a tumor involving the alveolar ridge and extending into the maxillary sinus), then the resection of the alveolar ridge usually provides adequate access for the complete resection. If necessary, either a transfacial incision, or endoscopic equipment may be used to supplement the access. Rarely is a full Weber-Ferguson incision (that involves an ethmoidectomy incision, lateral rhinotomy incison, and lip splitting incision) necessary. Osteotomies are generally made with power equipment, though osteotomes and rongeurs may at times be adequate.

Reconstruction of palate defects are generally done with an obdurator with a split thickness skin graft placed intraop on exposed soft tissue. There are a number of options to reconstruct orbit defects depending on whether skin was also resected. These options

include the pericranial-galeal flap discussed for anterior cranial base surgery, a free myogenous flap such as the rectus abdominus, covered with a skin graft (as the subcutaneous fat associated with using abdominal skin generally is too bulky fot this site), or if there is extensive skin loss, then a radial free flap or lateral thigh free flap.

Summary of Procedures

	Maxillectomy	Orbital Resection
Position	Head raised 30°, back raised (reduces bleeding)	
Incision	Same as external sinus approach; combinable with intraoral incisions.	Eyelash incision; if necessary add external ethmoidectomy
Special instrumentation	Paranasal sinus set; headlight	
Unique considerations	Nasal packing	; see reconstruction
Antibiotics	Cefazolin 1 gm + metronidazole 500 mg; or clindamycin 600 mg	Cefazolin 1 gm
Surgical time	2–4 h	1.5–3 h
EBL	100–300 mL	25–100 mL
Postop care	Same as endoscopic surgery	Reconstruction-dependent
Mortality	Rare	Very rare
Morbidity	Bleeding: 5% Transient Diplopia: 5% Infection: 5%	
Pain score	2–3 if no oral entry; 4–6 if palate	2–4

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Patient Population Characteristics

Age range	50–70	40–80
Male:Female	3:1	2:1
Incidence	Common	
Etiology	malignant tumors, selected benign tumors	Malignancies, rare benign proceses
Associated Conditions	Tobacco, alcohol, rare others	

Anesthetic Considerations

Preoperative

Typically, these patients are older males who may have concomitant cardiopulmonary disease. Their nutritinal status is not usually affected.

Airway	For patients presenting for maxilloectomy, careful inspection is warranted, although it is unlikely that the disease process will → airway compromise. With large tumors, space available for laryngoscope blade manipulation may be somewhat decreased. XRT typically is done postop.
Cardiovascular	Preop evaluation should focus on the patient's suitability for controlled ↓ BP: may be contraindicated in patients with advanced cerebrovascular or cardiovascular disease. **Tests:** ECG; other tests as indicated from H&P.
Laboratory	Tests as indicated from H&P.

Premedication Standard premedication (p. B-1).

Intraoperative

Anesthetic technique: GETA. Frequently, the typical anterior cranial base surgery begins with bifrontal craniotomy (usual craniotomy considerations apply), followed by the surgical work on the paranasal sinuses, *(Print pagebreak 212)* occasionally supplemented with a transethmoid incision. With that approach, the intraop surgical navigation set is frequently used, and a lumbar drain is placed after induction of anesthesia. Four percent cocaine is usually applied to the nasal passages by the surgeon →↑ BP & dysrhythmias. These procedures can be lengthy and very stimulating; the use of potent opioids (see Introduction, p. 174) is beneficial. The essential surgical requirement is ↓ bleeding into the field. Intraop hemorrhage may occasionally be brisk and substantial (in excess of 500 cc) during maxillectomy. Maintaining adequate circulating volume is crucial. Promotion of rapid awakening with full return of protective airway reflexes presents additional challenges to the anesthesiologist.

Induction	An opioid-based technique, as outlined previously (see Introduction, p. 174). Any iv induction agent can be safely used; ↓ dose in elderly and patients with significant cardiac disease. Oral tracheal intubation is performed with a small (6.0 mm ID) reinforced ETT to facilitate surgical manipulation inside patient's mouth. With large tumors, especially on the right side, care is necessary when performing DL to avoid bleeding. ETT can be secured with a short piece of tape over the chin. Placement of a small diameter esophageal temperature probe will not interfere with the surgical field.	
Maintenance	Moderate ↓ BP (unless contraindicated) usually is accomplished by titration with an inhalational agent and/or β-blockers. It is the author's preference to use desflurane for these procedures to rapidly adjust the depth of anesthesia. The use of IV remifentanil for the purpose of facilitating hemodynamic stability and controlled hypotension is highly beneficial. After the specimen has been removed, surgical stimulation decreases and the inhalational anesthetic should be significantly reduced to promote rapid awakening.	
Emergence	The stomach should be routinely suctioned at the end of the case (throat pack is removed only by the surgeon to facilitate placement of a dental prosthesis). Stomach emptying should be facilitated by administration of IV metoclopromide (10–20 mg). Nasal passages may be packed → obligate mouth breathing; oropharynx must be suctioned thoroughly and carefully. No dressing is applied postop. Washing blood off patient's face at the end of surgery is frequently accompanied by vigorous movement/shaking of the patient's head and the in-situ ETT. If sufficient doses of opioids have been used, patient will tolerate this well, without coughing/gagging/straining, while breathing spontaneously. Extubation must be smooth, with full return of protective airway reflexes. Hemoptysis may occur after extubation and the patient's mouth should be promptly covered with an O_2mask, to avoid contamination.	
Blood and fluid requirements	IV: 16 ga × 1 LR @ 5–7 cc/kg/h	Blood loss minimal-to-severe. It can be sudden and substantial.
Monitoring	Standard monitors (p. B-1) ± Arterial line	A-line monitoring is warranted for anterior cranial base surgery or in patients with significant cardiovascular disease.
Positioning	Head elevated 20–30° Table may be turned 90–180°. and pad pressure points. eyes.	
Complications		A risk of air embolism, with surgery on the paranasal sinuses should be kept in mind.
	VAE	Dysrhythmias may occur 2° significant surgical stimulation and break-through adrenergic responses.
	Dysrhythmias	
	Hypotension ↓↓ HR	↓ BP may be sudden 2° brisk blood loss. Trigeminocardiac reflex may occur during intraoperative manipulation of the

	Brain edema	trigeminal nerve. Careful fluid management, not to promote/exacerbate brain edema associated with the bifrontal craniotomy.

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Postoperative

Complications	Occult postop bleeding	Postop bleeding may cause the patient to swallow large quantities of blood, which represent an aspiration risk and may manifest as ↓ BP.
	Pneumocephalus	Persistent pneumocephalus (if the paranasal sinuses were opened) with symptoms of increased ICP.
Pain management	PCA (p. C-3) Parenteral opioids (p. C-2)	Pain is moderate

Suggested Readings

1. Donlon JV, Feldman MA: Anesthesia for eye, ear, nose, and throat surgery. In *Miller's Anesthesia,* 6th edition. Miller RD, ed. Philadelphia: Elsevier/Churchhill Livingstone, Philadelphia: 2005, 2527–49.

2. Dougherty TB, Nguyen DT: Anesthetic management of the patient scheduled for head and neck cancer surgery. *J Clin Anesth* 1994; 6:74–82.

Composite resection with marginal or segmental mandibulectomy (and neck dissection)

Surgical Considerations

Description: A composite resection means that part of the mandibular alveolar ridge is resected, often along with the floor of mouth and a part of the tongue, generally for advanced squamous cell carcinoma, though occasionally for osteoradionecrosis following complications of prior irradiation or for other malignancies such as osteosarcoma. In a **marginal mandibulectomy** bone inferior to the plane of the inferior alveolar nerve (which runs just below the teeth and provides dental innervation and cutaneous sensation to the lower lip and chin) is preserved. In a **segmental mandibulectomy** a through-and-through segment of bone is removed such that there is a bone gap. A marginal mandibulectomy may at times be reconstructed with intraoral advancement flaps in an edentulous patient, or a pectoralis major myocutaneous flap or radial free flap may be indicated. A segmental resection requires either bone replacement, such as fibula free flap, or a titanium bridging bar beneath a pectoralis major myocutaneous flap. A composite resection generally requires a tracheostomy although an intraoral marginal mandibulectomy repaired locally may allow a 2–3 d intubation, thereby avoiding tracheostomy.

Summary of Procedures

	Composite Resection (often with MRND)	**… and Free Flap**
Position	Supine, head extended and turned to opposite side.	+ Preparation of 2nd sterile site, such as arm or leg; two surgical teams
Incision	Intraoral and neck	and donor site

Special Instrumentation	Depends on technique used; headlights, suction or suction cautery, mouth gag.	Surgeon-specific, but point cautery, mouth gag, and plastic bilateral cheek retractor common.
Unique Considerations	Armored ETT converted to, or initial, tracheostomy.	Dependent on 2nd site
Antibiotics	Common is ampicillin or cefazolin 1gm [± metronidazole 500 mg]; or clindamycin 600 mg	
Surgical time	6–8 h	Add 3–6 h
EBL	200–400 mL; transfusions uncommon	; little additional loss
Postop care	Drain management, monitor for wound breakdown	+ ICU for flap surveillance
Mortality	<1%	
Morbidity	Bleeding: < 4% Infection ± fisuta: < 10% DVT/PE: < 1% medical: MI < 1% pneumonia: < 3%	flap failure requiring return to OR < 5% donor site morbidity
Pain Score	4–8	

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Patient Population Characteristics

Age range	40–70, occasionally older and younger
Male:Female	3:1
Incidence	Common
Etiology	SCC and other malignancy
Associated conditions	Smoking and alcohol; COPD, atherosclerostic heart disease

Neck dissection

Description: The goal of a neck dissection is a lymphadenectomy either to remove known cervical metastases (an N+ neck) or as a staging procedure in a patient apparently without clinically or radiologically involved nodes (an N0 neck) but at significant risk nevertheless. The most common indication by far is in the management of squamous cell carcinoma (SCC) of the head and neck. For the purpose of discussing a neck dissection, the neck can be divided into five levels. Level 1 is the tissue that is inferior to the mandible, anterior to the posterior belly of the digastric muscle, and superior to the hyoid bone, including the submental triangle between the left and right anterior belly of the digastric muscles. The most prominent structure in level 1 is the submandibular gland. Level 2 through 4 includes the tissue beneath and anterior to the sterncleidomastoid muscle (SCM): level 2 is superior to the hyoid bone, level 3 between the hyoid and cricoid bone, and level 4 is inferior to the cricoid. Level 5 contains the tissue between the posterior edge of the SCM and the anterior edge of the trapezius muscle.

There are several different kinds of neck dissection, depending on which levels are removed:

a. **Radical neck dissection (RND)** or **modified radical neck dissection** (**MRND**): this involves the removal of levels 1–5. Except in markedly advanced disease, seldom is a RND (which removes the internal jugular vein, SCM, and accessory (XI) nerve) necessary. A MRND preserves one or more of those three structures, generally at least the XI nerve. The term *functional* neck dissection is sometimes used to indicate preservation of all three of these three structures. A MRND (or RND) is generally done when there is N+ disease. Similar surgery may also be necessary to remove extensive tumors other than SCC, such as a sarcoma or paraganglioma. An extended neck dissection involves removal of additional tissue, such as muscles deep to the superficial layer of the deep cervical fascia. MRND is a common additional procedure done for an N+ neck at the time of removal of a primary SCC of the head and neck.

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b. **Selective neck dissection** (SND) removes less than all five levels, generally for N0 disease when adjacent surgery is planned or in an effort to ascertain there is no histologically demonstrable disease, thereby avoiding postop irradiation to the primary site and neck. The two most common types of SND are:

   i. **Supraomohyoid neck dissection** (**SOHND**): this removes levels 1–3, generally in a patient with an oral cavity SCC with a depth of greater than 3.5- to 5-mm at risk for nodal involvement despite a clinically N0 neck.

   ii. **Lateral neck dissection:** removes levels 2–4, generally in N0 patient with glottic or supraglottic carcinoma in whom, again, it is hoped that postop RT may be avoided.

Summary of Procedures

	MRND (or RND)	SOHND
Position	Supine, head extended and turned to opposite side; table 90° or 180°.	
Incision	Common incisions include a reverse hockey (submandibular RSTL to mastoid tip then extended inferiorly); utility/hockey; superior and inferior neck RSTL (McFee).	7 cm RSTL (resting skin tension line) incision 3 cm inferior to the mandible, beginning anterior to SCM extending toward the mentum.
Special Instrumentation	Major head & neck set; headlights	
Unique Considerations	Avoid paralysis until after marginal mandibular nerve and XI identified. If bilateral, larnygeal edema may occur; dissection near carotid body and vagus may produce transient bradycardia.	
Antibiotics	Cefazolin 1gm [and metronidazole 500 mg if UADT entry planned]; or clindamycin 600 mg	
Surgical time	2–4 h	1.5 h
EBL	50–250 mL; transfusions rarely indicated	
Postop care	Drain management	
Mortality	< 1%	
Morbidity	Unanticipated neuropathy (e.g., XII, X, VII marginal branch, recurrent laryngeal nerve and phrenic nerve) < 1%; chyle leak < 2% Hematoma < 4% Infection < 5% DVT/PE 1% XI weakness expected Shoulder pain 20%	
Pain Score	4–8	2–4

Patient Population Characteristics

Age range	40–80, occasionally older and younger
Male:Female	3:1
Incidence	Common
Etiology	1° site SCC; Smoking and alcohol
Associated conditions	COPD, atherosclerostic heart disease

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Anesthetic Considerations

Preoperative

Many of these patients are older males with a long Hx of heavy smoking and ETOH use, and have a high incidence of associated cardiopulmonary diseases. Nutritional status of the patients may be poor and should be optimized before surgery. Neck dissections are lengthy, but are rarely associated with significant blood loss, except in patients who have undergone radiation therapy.

Airway	Airway management may be difficult 2° limited head and neck mobility, ↓ mouth opening, distorted airway, ↓ pharyngeal space and fixation of tissues 2° tumor expansion, radiation fibrosis or previous surgeries. Backup plans for airway management are essential, and a review of preop findings on indirect laryngoscopy and/or CT scan with the surgeon may be helpful in planning a strategy for intubation. If a difficult intubation is foreseen, awake FOI may be the technique of choice (see Anesthetic Considerations for Laryngectomy, p. 202). Emergent tracheostomy may technically be very difficult 2° advanced disease, neck edema, previous surgeries and distorted anatomy.
Respiratory	High incidence of chronic bronchitis and COPD. **Tests:** CXR; preop ABG in patients with advanced COPD, CO_2 retention and O_2 dependence. Flow-volume loops may be helpful in patients with symptoms of partial airway obstruction.
Cardiovascular	Careful assessment of cardiac risk factors and functional status. Documenting asymptomatic neck bruits or existing carotid artery stenosis, as well as any Sx of compromised cerebral circulation is important (see Emergence, below). HTN must be controlled preop especially in patients presenting for radical neck dissection and flap reconstruction. Uncontrolled HTN in these patients carries additional risk of exaggerated hemodynamic responses postop 2° surgical denervation of the carotid sinus (discussed below). **Tests:** ECG. Consider carotid ultrasound, cardiac stress testing and imaging studies if indicated from H&P.
Neurologic	See Preoperative Considerations for Laryngoscopy/Bronchoscopy/Esophagoscopy, p. 180). **Tests:** As indicated from H&P.
Hematologic	In cases of malignancy or chronic disease, anemia or coagulopathies may be present. **Tests:** CBC, coagulation studies.
Laboratory	LFTs, electrolytes, albumin, BUN and creatinine. Other tests as indicated from H&P.
Premedication	Standard premedication (p. B-1). Avoid premedication in patients with symptoms of partial airway obstruction.

Intraoperative

Anesthetic technique: The anesthetic considerations for **composite resection and neck dissection** are similar. The use of deep and superficial cervical plexus blocks, as well as cervical epidural anesthesia, either alone or in combination with light GETA, has been described in the literature, but used rarely. GETA is virtually universally employed. The specific surgical requirements for the anesthetic technique are outlined above (see Introduction, p. 174). Straining or coughing/gagging on the ETT during emergence from anesthesia is particularly undesirable in neck surgery 2° easily provoked bleeding and swelling at the surgical site. Smooth

emergence from anesthesia is essential. Use of a FLMA in major cancer neck surgery is dubious.

Induction	Choice of induction will depend on the degree of the airway compromise and anatomical location of any obstructing lesion. The airway may need to be secured asleep, with the patient breathing spontaneously, awake (FOI), or a tracheostomy may need to be performed pre-induction. In patients with uncompromised airways, potent opioids (see Introduction, p. 174) can be safely used for induction. The induction dose of a hypnotic agent frequently must be reduced because of the patients' age, pre-existing medical conditions, and hypoalbuminemia.	
Maintenance	Maintaining moderate ↓ BP (see Introduction, p. 174) and aggressive treatment of ↑ BP are necessary. In patients with flap reconstruction, ↑ BP may overcome vasospasm, dislodging a hemostatic blood clot or poorly tied ligature → formation of a flap hematoma. Muscle relaxation is usually avoided to facilitate identification of nerves. All inspired gases should be humidified to minimize ↓ T° and propensity for mucous plugging in this patient population. However, the use of low gas flows is preferred to use of an in-circuit humidifier. Venous air embolism (VAE) during radical neck surgery occurs very rarely; maintaining adequate intravascular volume and PPV will further ↓ the incidence of this complication. If a large collection of air bubbles is observed by the surgeon in the internal jugular vein, the anesthesiologist should be notified immediately; these bubbles can be safely aspirated with a fine needle by the surgeon. Vagal reflexes from the carotid sinus may cause ↓ HR and ↓ BP. Transient prolongation of the QT interval during right radical neck dissection has been described, and may potentially progress to ventricular arrhythmias and even cardiac arrest. Tracheostomy can be performed as part of the radical neck dissection with implications for anesthesia management (see Anesthetic Considerations for Tracheostomy, p. 187).	
Emergence	If airway compromise is present preop, but tracheostomy was **not** performed, consider extubating the patient over an airway exchange catheter to facilitate for possible reintubation. The majority of patients with microvascular flap reconstruction will have a tracheostomy placed and continued on overnight ventilatory support in the ICU. Other patients with a tracheostomy should be awakened in the OR, to exclude possible intraop embolic stroke (carotid atherosclerosis) before their transfer to the PACU or ICU. Administration of iv labetalol before awakening may prevent rebound hypertension. Up to 10% of patients may develop a sustained hypertensive response postop, probably 2° denervation of the carotid sinus; Rx aggressively 2° ↑ risk of stroke.	
Blood and fluid requirements	IV: 16(18) ga x 1 NS/LR @ 5–7mL/kg/h Fluid warmer ± humidifier	Blood loss is typically gradual. Sudden blood loss resulting from injury to the internal jugular vein or carotid artery can be surgically controlled.
Control of blood loss	Surgical hemostasis Deliberate ↓ BP	Continue aggressive Rx of ↑ BP in the PACU.
Monitoring	Standard monitors (p. B-1) ± Arterial line ± CVP line Foley catheter	A-line may be indicated for patients with pre-existing severe cardiac and pulmonary disease, chronic renal insufficiency (CRI), symptoms of cerebrovascular insufficiency, location of tumor near the carotid artery, or in patients presenting for lengthy procedures, including microvascular flap reconstruction. CVP monitoring may be warranted in severely malnourished patients, patients with severe COPD, patients with CRI and patients presenting for microvascular flap reconstruction.
Positioning	Usually supine, head elevated 30° Table turned 180° and pad pressure points. eyes.	2° carotid sinus stimulation; Rx: stop surgery; lidocaine infiltration of the carotid

Complications	Vagal reflexes: ↓ HR and ↓ BP	sinus by the surgeon; iv atropine.
	QT interval (with right radical neck dissection)	Probably caused by interruption of cervical sympathetic outflow to heart.
	Dysrhythmias	Due to either the carotid sinus stimulation or the ↑ QT interval.
VAE	↓ $ETCO_2$ ↑ ETN_2 ↓ BP ↑ ST segment "Mill wheel" murmur Dysrhythmias	With large veins open in the neck, VAE is possible, and may account for unexplained ↓ BP and/or dysrhythmia. Rx: notify surgeon (compress open neck veins); flood field with NS; left lateral decubitus/head-down position; aspirate CVP; FiO_2=1.0; circulatory support (fluid, pressors, as required).

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Postoperative

Complications		2° carotid sinus denervation; Rx: aggressive pharmacological intervention.
	↑ BP and ↑ HR	Facial nerve injury → facial droop. Recurrent laryngeal nerve injury can result in VC dysfunction. Phrenic nerve injury → respiratory problems 2° diaphragmatic paralysis.
	Nerve injury Diaphragmatic paralysis	
	Pneumothorax	Pneumothorax may occur with low neck dissection. Dx and Rx: see Postop Complications after Laryngoscopy/Bronchoscopy/Esophagoscopy, p. 187
	Agitation	Agitation → ↑$PaCO_2$ ↓PaO_2 ↑HR. Rx: restrictive neck dressings; evacuate any hematoma; reestablish airway with ETT; FiO_2=1.0; ventilatory support, if required.
Pain management	PCA (p. C-3) Parenteral opiates (p. C-1)	
Tests	CXR	For position of tracheostomy tube, evidence of pneumothorax and CVP line placement.
	ECG	For diagnosis of rhythm disturbances.

Suggested Readings

1. Bonner S, Taylor M: Airway obstruction in head and neck surgery. *Anaesthesia* 2000; 55:290–1.

2. Brown BR: Anaesthesia for ear, nose, throat and maxillofacial procedures. In *International Practice of Anaesthesia*. Prys-Roberts C, Brown BR, eds. Butterworth-Heinemann, Oxford: 1996, 2–9.

3. Dougherty TB, Nguyen DT: Anesthetic management of the patient scheduled for head and neck cancer surgery. *J Clin Anesth* 1994; 6:74–82.

4. Mason RA, Fielder CP: The obstructed airway in head and neck surgery. *Anaesthesia* 1999; 54:625–8.

5. McGuirt WF, May JS: Postoperative hypertension associated with radical neck dissection. *Arch Otolaryngol Head Neck Surg*

1987; 113:1098–110.

6. Prasad KC, Shanmugam VU: Major neck surgeries under regional anesthesia. *Am J Otol* 1998; 19:163–9.

7. Rice JH, Gonzalez RM: Large visible gas bubbles in the internal jugular vein: a common occurrence during supine radical neck surgery? *J Clin Anesth* 1992; 4:21–4.

8. Rice M, Turner M, Carapiet D: The use of the laryngeal mask airway in maxillofacial surgery. *Anaesthesia* 2002; 57:826.

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Lymph Node Biopsy

Surgical Considerations

Description: An open cervical node biopsy is indicated when a fine needle aspiration biopsy (FNA) has proven inadequate or is felt likely to be inadequate (as in determining a type of lymphoma). This can be done under local anesthesia, with or without monitoring, or under general anesthesia. A node is chosen based on its likelihood to answer the clinical question and minimization of operative risk to adjacent structures, especially, for example, the accesory nerve that runs in level 5 (posterior triangle) from about the midportion of the posterior border of the SCM toward the posterior clavicle and may be quite superficial.

Operative and anesthesia considerations are similar to that of a SOHND, except that the incision should be only a few cm and its location is variable though still in a RSTL (resting skin tension line), pain should be low, a small drain or no drain is used, and the patient should be able to go home the day of surgery. Often the surgeon will request a frozen section to be sure there is diagnostic tissue available.

Summary of Procedures

Position	Supine, head extended and turned to opposite side
Incision	small (often requiring only local anesthesia)
Antibiotics	Cefazolin 1gm
Surgical Time	10 min
EBL	minimal
Postop Care	Drain management
Mortality	Very rare
Morbidity	rare injury to adjacent structures (e.g., accessory nerve)
Pain Score	1–3

Patient Population Characteristics

Age range	wide range
Male:Female	1:1
Incidence	Common
Etiology	In adults: 80% benign: pleomorphic adenoma (benign mixed tumor) 75% of these. 20% malignant: low grade mucoepidermoid carcinoma, adenoid cystic carcinoma, other. Chronic sialadenitis/stone rare

	In children: a greater % malignancy; 60% benign, 35% malignant. Chronic sialadenitis/stone <5%
Associated conditions	none

Suggested Reading

1. Nair MB, Bailey PM: Review of uses of the laryngeal mask in ENT anesthesia. *Anaesthesia* 1995; 50:898–900.

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Parotidectomy: Superficial, Total, or Radical

Surgical Considerations

Description: A **superficial parotidectomy** (more accurately a lateral or a **supraneural parotidectomy**) removes tissue of the parotid lateral to the facial nerve, dissecting and protecting the facial nerve (Fig. 3-8). It usually is performed for a tumor, but occasionally is performed for infectious disorders or to enable the surgeon to approach tumors of the deep lobe. A **total parotidectomy** is performed for either infectious disorders or for parotid tumors that arise in or extend medial to the facial nerve. The integrity of the facial nerve is preserved during total parotidectomy, as long as it is not involved with malignancy. It may be combined with a neck dissection or with a modified temporal bone resection when the tumor extends into the ear canal or middle ear or invades the facial nerve at the base of the skull.

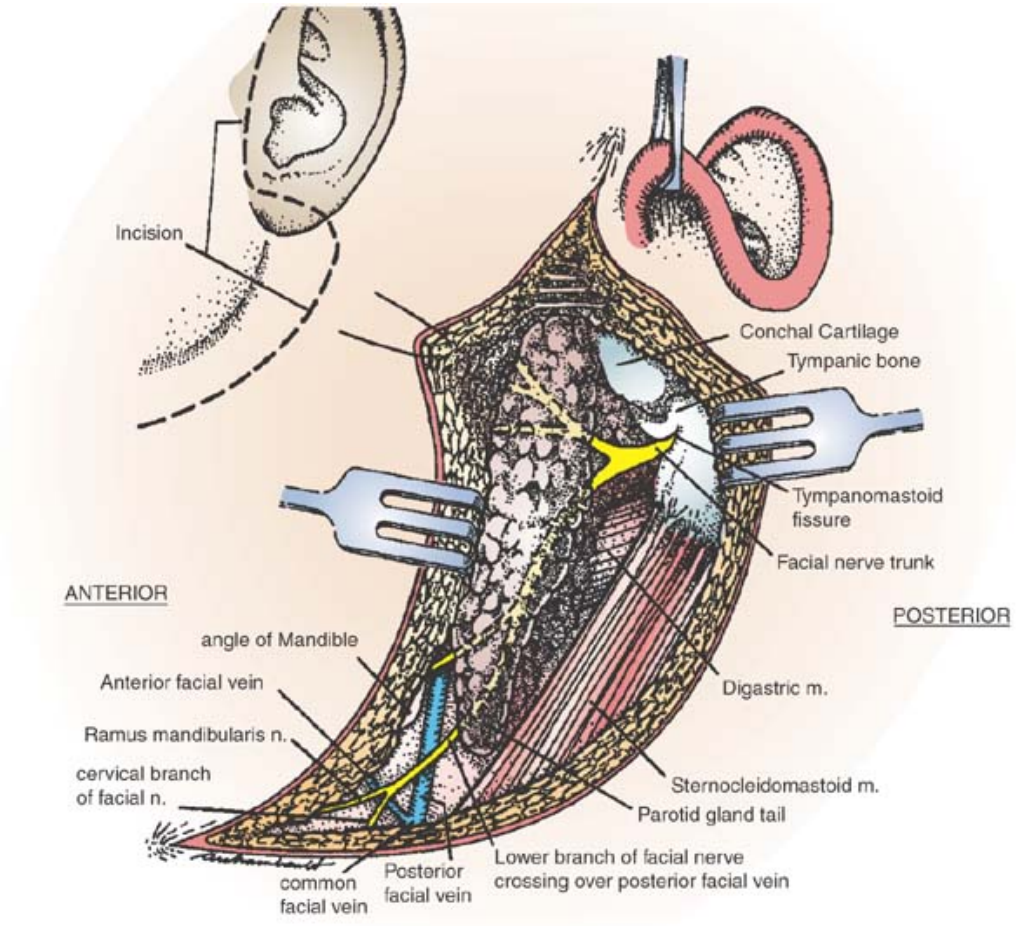

Figure 3-8. Inferior approach to facial nerve. The lower branch of the facial nerve is found immediately external to the posterior facial vein as it exits the lower pole of the parotid gland. The lower branch may divide into the ramus mandibularis and cervical branches before or after crossing the posterior facial vein. The lower branch of the facial nerve is dissected proximally to the facial-nerve trunk. The posterior facial vein should not be confused with the

external jugular vein, as the facial vein runs deep to the sternocleidomastoid muscle, whereas the external jugular vein lies superficial to this muscle. Elevation of the tail of the parotid gland greatly facilitates this dissection, which must be accomplished in a plane between the posterior facial vein and the parotid gland. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

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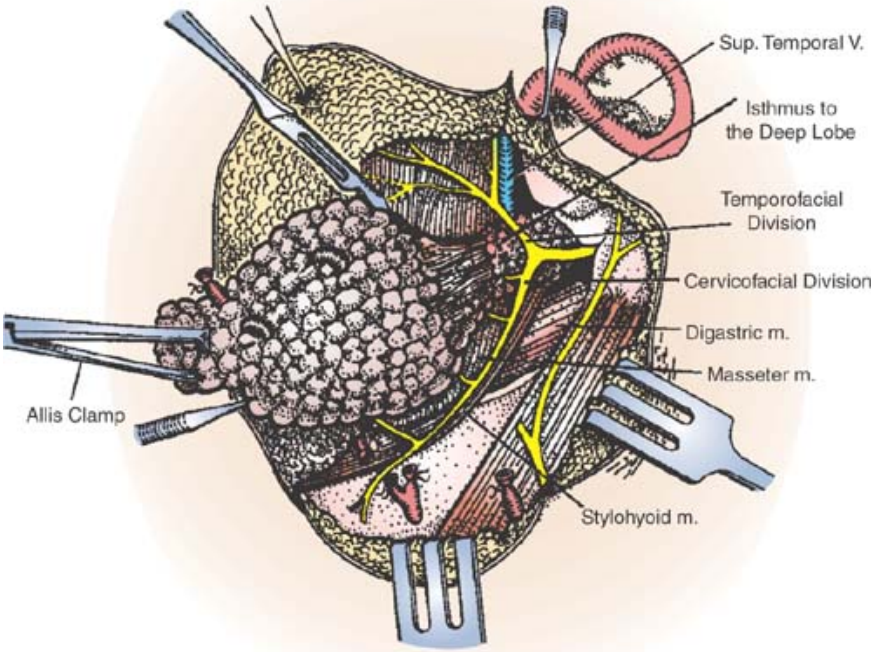

Figure 3-9. The parotid gland has been dissected from the trunk, divisions, and branches of the facial nerve. The anterior projection of the gland has been dissected free, and the parotid duct is being ligated. This dissection is conducted, for the most part, with a hemostat clamp. First, tunnels are created lateral to the branches; and the fascia between tunnels is incised as the gland is dissected forward. The facial-nerve stimulator is a useful adjunct to this dissection. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

A **radical parotidectomy** removes the total parotid gland, together with the facial nerve, (which usually is reconstructed with a facial-nerve graft). The mastoid may have to be drilled to get a healthy proximal end of the facial nerve. **Microsurgical techniques** are then used to graft the resected nerve. The donar nerve may be the greater auricular nerve or the sural nerve.

Usual preop diagnosis: Benign or malignant tumor; occasionally infectious.

Summary of Procedures

	Superficial/Total	Radical
Position	Supine; head turned slightly to opposite side	
Incision	Preauricular, extending into neck; has many variations, including modified face-lift incision.	May require postaural extension for mastoid access.
Special instrumentation	Facial nerve stimulator, facial nerve monitor.	+ drill for mastoidectomy; microscope/microsurgical instruments and 9-0 nylon for nerve reanastomosis.
Unique considerations	Initial muscle relaxation is not indicated 2° facial nerve identification. Tape oral	

	ETT to the opposite side of the mandible.	
Antibiotics	Cefazolin 1 g	
Surgical time	1.5–4 h	4–8 h
EBL	25–200 mL	500–700 mL for total parotidectomy, neck dissection, and modified temporal bone resection. Sudden, large blood losses do not occur; transfusion usually not necessary.
Mortality	Very rare	
Morbidity	Dysesthesia or anesthesia of the greater auricular nerve: 100% (almost all will recover within 1 yr). Facial nerve weakness (temporary): 20–50% Frey's syndrome: < 5% will have clinically both ersome gustatory sweating. Bleeding: 4% Infection: 4% Permanent facial nerve paralysis: < 1%	Facial nerve loss: With graft, function returns slowly over 1 yr.
Pain score	2–4	4–6

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Patient Population Characteristics

Age range	Infants–old age
Male:Female	1:1
Incidence	Common
Etiology	Benign mixed tumor (pleomorphic adenoma) (75%); variety of low- to high-grade malignant cancers (25%); chronic sialoadenitis (results from ductal strictures and/or stones) (rare)
Associated conditions	Nonspecific

Submandibular Gland Excision

Surgical Considerations

Description: Removal of the submandibular gland is performed for either chronic sialoadenitis due to ductal strictures and/or stones or benign or malignant tumors of the submandibular gland. (General anatomy of the area is shown in Fig. 3-10.) The patient lies supine with a pillow under the shoulder, and head turned slightly to the opposite side. A skin crease incision is made below the mandible and skin flaps elevated. The marginal mandibular nerve is identified or may be avoided by identifying the facial vein and dissecting deep to its plane, employing the **Hayes-Martin maneuver.** Dissection is carried out within the capsule of the submandibular gland, which is then excised and removed. Frozen section usually is performed; and, if necessary, further excision, including a neck dissection for high-grade malignancies, is done.

Variant procedure or approaches: Occasionally, it may be necessary to perform a **neck dissection** (radical or functional) in the case of high-grade malignancy.

Usual preop diagnosis: Chronic sialoadenitis; stones; benign or malignant tumors

Summary of Procedures

Position	Supine
Incision	Upper neck skin crease
Special instrumentation	Occasionally, facial nerve stimulator
Unique considerations	If surgeon plans to use facial nerve stimulator, muscle relaxation is contraindicated.
Antibiotics	Usually not indicated
Surgical time	0.5–1 h
EBL	25 mL (400 mL if neck dissection is done)
Postop care	PACU → room or home
Mortality	Minimal
Morbidity	Marginal mandibular nerve paresis or paralysis: 20% Bleeding: 4% Infection: 4% Lingual dysesthesia: 1% XIIth nerve paresis or paralysis: #1%
Pain score	2–4

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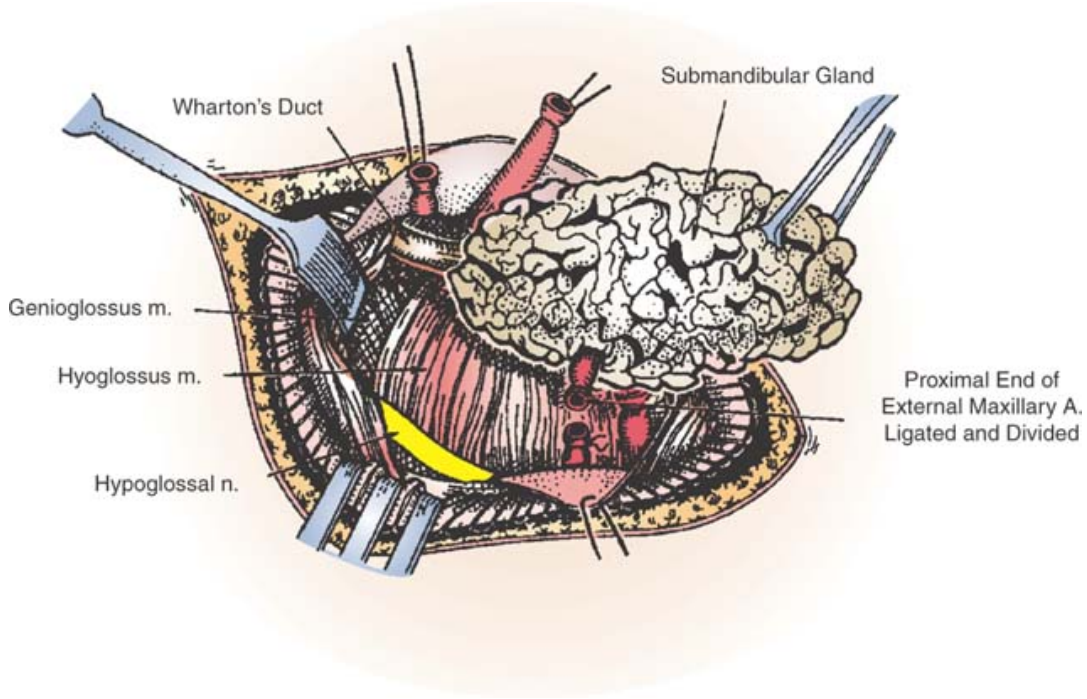

Figure 3-10. Exposure of the submandibular gland. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, Baltimore: 1996.)

Patient Population Characteristics

Age range	Unlimited
Male:Female	1:1
Incidence	Rare
Etiology	Chronic infection Neoplasia: 60% of tumors are benign with the remaining being low- and high-grade malignancies.

Associated conditions	Nonspecific

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Anesthetic Considerations

(Procedures covered: parotidectomy, submandibular gland excision)

Preoperative

The majority of these patients are > 40 yr, and any coexisting medical conditions should be fully evaluated. Diseases of the parotid gland have been associated with ETOH abuse and with autoimmune disease (e.g., Mikulicz-Sjögren syndrome); therefore, Sx of these conditions should be sought.

Respiratory	Airway may be affected by impaired mouth opening or parotid gland enlargement. Patients with involvement of the masseter muscle may present with trismus. **Tests:** As indicated from H&P.
Neurological	Surgical approach to the parotid gland will place the facial nerve at jeopardy; any preop facial nerve deficits should be documented. Also see Preoperative Considerations for Laryngoscopy/Bronchoscopy/Esophagoscopy, p. 187. **Tests:** As indicated from H&P.
Hematologic	Submandibular and parotid malignancies may be associated with chronic debilitation and anemia. **Tests:** CBC
Laboratory	Other tests as indicated from H&P. Liver panel and coags in patients with Hx of ETOH abuse.
Premedication	Standard premedication (p. B-1)

Intraoperative

Anesthetic technique: GETA is most commonly used. Use of a FLMA also has been advocated, but does not represent the author's preference due to the possibility of distorted surgical anatomy by the inflated FLMA cuff. The FLMA also may be displaced 2° surgical intrusion into the submandibular space and occasional intraoral surgical manipulation. These procedures involve meticulous surgical dissection and are characterized by alternating levels of stimulation: relatively long, stable levels of stimulation, with sudden adrenergic responses when surgery progresses into deeper fascial planes. (For essential surgical requirements, see Introduction, p. 174.) Emergence should be rapid enough to allow immediate patient cooperation for assessment of facial nerve function by the surgeon. Muscle relaxation with nondepolarizing NMB may or may not be contraindicated, depending on the surgeon's preference and type of surgery performed (inquire preop). Patients after **submandibular gland resection** may be discharged home the same day, while parotidectomy patients are admitted to the ward.

Induction	Opioid-based techniques (see Introduction, p. 174) are beneficial. Standard IV induction with propofol (1–2 mg/kg) is typically employed. ETT should be carefully secured on the nonoperative side. Nasal intubation may be requested by the surgeon (inquire preop) for selected cases, to allow full manipulation of the patient's jaw.
Maintenance	Moderate ↓ BP (see Introduction, p. 174) will greatly improve operating conditions and speed up the surgery. Anticipate ↑ anesthetic requirements in patients with Hx of ETOH abuse. If nondepolarizing NMBs are used, maintain one twitch to permit quick reversal of the block if requested.
Emergence	Smooth emergence is extremely desirable and absence of reaction to the ETT is obligatory if facial nerve repair has been performed.
Blood and fluid requirements	EBL typically 200 mL IV: 18 ga × 1 NS/LR @ 3–5 mL/kg/h 3rd spacing is usually minimal.
Monitoring	Standard monitors (p. B-1)

Positioning	Table usually is rotated 90–180° away from the anesthesiologist. pad pressure points. eyes.	

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Postoperative

Complications	Facial paralysis 2° surgical trauma	Notify surgeons.
Pain management	Parenteral opiates (p. C-2) PCA (p. C-3)	

Suggested Readings

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2. Nair MB, Bailey PM. Review of uses of the laryngeal mask in ENT anesthesia. Anaesthesia 1995;50:898–900.

Endoscopic Sinus Surgery

Peter H. Hwang
Sarmela T. Sunder

Surgical Considerations

Description: Sinus surgery is performed most often for the management of chronic sinus disease, nasal polyps, recurrent sinus infections, or for neoplastic conditions that may cause obstruction of the sinus cavities. This surgery includes either external procedures, through the skin or oral cavity, or endoscopic approaches, through the nostrils. The endoscopic approach—the preferred technique for most surgeons—is called **endoscopic sinus surgery (ESS)** or **functional ESS (FESS).** Other surgical procedures—including septoplasty, turbinate reduction, and, occasionally, sleep apnea surgery involving the tonsils, palate, and oropharynx—may be combined with FESS.

Endoscopic Sinus Surgery: ESS or FESS is a minimally invasive technique that utilizes telescopes intranasally to visualize and access the paranasal sinuses and anterior skull base. The primary indication for ESS is chronic sinusitis that has failed to clear with aggressive medical therapy. The goal of ESS is to open the sinuses through a transnasal minimally invasive approach. Inflamed bone and tissue are cleared from the outflow tracts of the sinuses under direct endoscopic illumination and magnification. By surgically enhancing the drainage and ventilation of the sinuses, normal mucociliary clearance can be restored. Depending on the extent of disease, surgery may involve the maxillary, ethmoid, sphenoid and/or frontal sinuses. If all four sinuses are being treated, a maxillary antrostomy is typically performed first, followed by an ethmoidectomy. A sphenoidotomy and frontal sinusotomy usually follow thereafter.

Providing openings (drainage, aeration) to the sinus cavities and obtaining tissue for pathological evaluation are the main aims of ESS. Patients are orally intubated and a throat pack can be placed in the pharynx to decrease the amount of blood swallowed. Oral gastric tubes are recommended if more than minimal bleeding is expected. Following induction of anesthesia, local medications are applied to the nasal cavity, including injection of 1% lidocaine with 1:100,000 epinephrine and/or topical application of 4% cocaine. It is important that these local medications be noted in the anesthesia record, as complications (HTN, dysrhythmias, seizures) from local application have been reported. Patients with a history of illicit cocaine use should be warned of potential drug interactions, and the intraop use of vasoactive drugs should be limited to avoid unexpected cardiovascular events.

At the end of the procedure, packing may be placed. It is imperative that any pharyngeal or throat pack be removed before the end of the procedure to avoid airway destruction.

Sinus surgical procedures may use **image guidance or surgical navigation tools.** These computer-assisted techniques involve a preop CT or MRI scan to create a navigational map for the surgeon to localize disease, normal *(Print pagebreak 226)* tissues, and

the boundaries of the surgical dissection. Surrounding the sinuses are several vital structures, including the periorbital tissues (e.g., orbital muscles, lacrimal apparatus, and the optic nerve), the sphenopalatine artery, ethmoid arteries, the carotid artery, as well as the skull base.

Variant procedure or approaches: For **external approaches** to sinus surgery, see External Sinus Surgery, p. 231.

Usual preop diagnosis: Nasal polyps; chronic sinusitis; recurrent acute sinus infections, benign and malignant tumors, inverted papilloma, and management of previous surgical complications (e.g., repair of CSF leak, lacrimal duct injury, and persistent or remnant ethmoid cells, scar tissue formation)

Preoperative Management: Patients should receive a decongestant nasal spray, such as oxymetazoline, pre-op to reduce nasal edema. This is generally given 30 min. before the start of the case, with repeat administration every 10–15 min. Preop antibiotics or steroids will vary depending on surgeon preference. Typically, an antibiotic with gram-positive and some gram-negative coverage (such as cephalexin) and an intravenous steroid such as dexamethasone are administered.

Intraoperative Management: ESS is usually performed under GA, using either endotracheal intubation or an LMA. The LMA offers the potential advantages of reducing the entry of blood into the stomach and causing less bucking or coughing during emergence, (which may provoke unnecessary bleeding from the surgical site). The tube should be taped securely to the left side or midline of the patient's mouth. The OR table is routinely turned 90° or 180°, and the patient is positioned with the head slightly elevated. The surgeon sits or stands at the patient's right and operates from a video monitor positioned at the patient's head.

The eyes are taped but should remain visible in the surgical field throughout the procedure so that the status of the orbits may be noted by the surgeon. The presence of ecchymosis or proptosis suggests a transgression of the thin bony orbital wall and requires immediate attention. Throughout the procedure, the surgeon may palpate the orbit externally while endoscopically evaluating for dehiscences of the orbital wall, which if present will reveal transmitted movement of orbital fat or periorbita.

In more complex FESS or endoscopic skull base surgery, the surgeon may use a stereotactic navigation system to map out the surgical field according to a preoperatively acquired CT or MRI scan. During preparation of the patient, a localizing headset is placed over the patient's forehead, and a computer workstation tower is positioned adjacent to the head of the patient. After a registration process, a navigating probe communicates with the workstation via electromagnetic or infrared technology to provide triplanar localization of the probe tip relative to critical anatomic structures in and adjacent to the sinuses.

Hemostasis is critical in endoscopic sinus surgery, where the small lens of the endoscope (4 mm) can be easily obscured by blood. When possible, a hypotensive anesthesia regimen can reduce bleeding and thereby optimize the surgeon's view of the operative field. It may be reasonable to maintain blood pressure at approximately 80% of the preop level.

To improve hemostasis, the surgeon may place pledgets soaked in a vasoconstrictive agent such as cocaine, oxymetazoline, or epinephrine in the nasal cavity before starting the case. A transoral or transnasal sphenopalatine ganglion block may be performed using 1% lidocaine with 1:100,000 epinephrine, which will provide vasoconstriction of the sphenopalatine artery. The lateral nasal wall and middle turbinate are also infiltrated with lidocaine/epinephrine. Additional vasoconstrictor-soaked pledgets may be placed in the operative field during the procedure to control oozing.

Complications of Endoscopic Sinus Surgery: Along the boundaries of the paranasal sinuses lie important structures that may be injured in the course of the procedure.

Maxillary Sinus: Just anterior to the maxillary sinus ostium lies the **nasolacrimal duct**. Injury to this structure, manifesting as excessive tearing, will not usually be evident until postop.

Ethmoid Sinus: Two critical boundaries of the ethmoid sinus are the medial orbital wall laterally and the skull base superiorly. **Transgression of the orbit** may result in medial rectus injury, prolapse of orbital fat, or orbital hemorrhage. If orbital hemorrhage progresses to the point of marked proptosis, vision may be threatened and an emergent decompression of the orbit may be required via lateral canthotomy and cantholysis.

The superior extent of the ethmoid dissection is the cribriform plate and the anterior skull base. A breach through the ethmoid roof may result in a **cerebrospinal fluid leak**. Cerebrospinal fluid leaks require immediate repair using autogenous tissue grafts and require an inpatient recovery period. Vigorus bag mask ventilation should be avoided in patients with known skull base defects because of the risk of creating a pneumocephalus.

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Sphenoid Sinus: The sphenoid sinus, the posterior most of the paranasal sinuses, lies adjacent to critical structures of the parasellar

region. The **carotid artery** and **optic nerve** run along the superolateral wall of the sphenoid sinus. Any significant bleeding on entry into or while working in the sphenoid sinus is concerning for potential carotid injury. Carotid artery injury requires emergent tamponade possible, fluid resuscitation, and angiography with embolization.

Frontal Sinus: Endoscopic approaches to the frontal sinus are especially challenging because of the narrowness of the region. Violation of the cribiform plate medially or the orbital wall laterally may lead to complications of **CSF leak** or **eye injury**, respectively.

Postop Management: In the PACU, patients s/p ESS require continued monitoring for possible delayed manifestation of complications. Maintaining normotensive hemodynamics is extremely helpful in controlling postop bleeding. Changing nasal dressings for oozing every 20–30 min is expected, but brisker bleeding should be evaluated by the surgeon for possible arterial sources requiring intervention.

Orbital injury can also present in the postop period with significant pain, diminished visual acuity, diplopia, proptosis, or ecchymosis. Any complaints of eye pain or visual changes need to be addressed urgently. The surgeon must be alerted immediately and an ophthalmology consult should be considered.

Altered mental status, focal neurologic exam, or severe headache may indicate a possible intracranial complication. Clear rhinorrhea, especially unilateral, should be closely evaluated for the possibility of cerebrospinal fluid leak.

Summary of Procedures

Position	Supine; table 90° or 180°
Incision	Mucosal, intranasal
Special instrumentation	4 mm nasal endoscopes, camera monitor, computer-guided navigation system
Premedication	Cefazolin 1gm, dexamethasone 8–12 mg
Surgical time	1–3 h
EBL	50–300 mL; transfusions rare
Postop care	PACU monitoring for surgical complications; discharge home from PACU
Mortality	Rare
Morbidity	1% major complication rate (see complications of ESS above)
Pain Score	2–3

Patient Population Characteristics

Age range	15–80
Male:Female	1:1.5
Incidence	Common
Etiology	Medically refractory chronic sinusitis
Associated conditions	Asthma, allergic rhinitis, migraine

Other Applications of Endoscopes in Sinonasal Surgery: Although the most common indication for endoscopic sinus surgery is medically refractory chronic sinusitis, endoscopic techniques can be applied to wide range of sinonasal and skull base pathology. OR setup and patient positioning is identical to that for ESS (except as noted).

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Turbinate Reduction: The inferior turbinate is the largest of the nasal turbinates (inferior, middle, superior) and when hypertrophied can cause nasal obstruction. Various methods exist for inferior turbinate reduction and include radiofrequency ablation, cauterization, submucosal resection, partial resection and out-fracture. Both turbinate cauterization and RF ablation involve inserting a probe into the soft tissue of the turbinate and producing a coagulative lesion, which ultimately contracts to reduce the

turbinate soft tissue. Similarly, submucosal reduction involves making an incision through the mucosa and mechanically reducing the underlying soft tissue. Partial resection of the turbinate involves cutting through the bone, soft tissue and mucosa of the anterior one-third of the turbinate. At the conclusion, the cut edges are cauterized. The main adverse event from the majority of procedures on the turbinate is bleeding, which is usually controlled with cautery or nasal packing.

Septoplasty: Septal deviation may arise congenitally or during periods of rapid craniofacial growth, or as well from nasal trauma. Septoplasty is indicated when the septal deviation causes obstructed nasal breathing. Through an incision in the nasal vestibule, a mucoperichondrial septal flap is elevated to reveal deflections in the underlying septal cartilage and bone. Selective excision of bone and cartilage allows the septum to return to a midline position. Although the procedure may be performed using direct visualization with a headlight, nasal endoscopy provides superb visualization and allows for precise surgical maneuvering.

Control of Epistaxis: Control of epistaxis can usually be performed in the clinic; however, the OR provides a controlled environment suitable for high risk patients and patients with profuse bleeding. Under endoscopic visualization, bleeding sites can be readily identified and controlled with cautery or laser. A more definitive procedure to control posterior epistaxis is sphenopalatine artery ligation. The artery is identified at the posterior-most aspect of the middle turbinate through a mucoperiosteal incision. The artery is then cauterized or ligated with surgical clips.

Orbital Decompression: Endoscopic orbital decompression is performed for Grave's ophthalmopathy to preserve diminishing vision and to improve cosmesis associated with exophthalmos. An ethmoidectomy is performed first, followed by removal of the medial orbital wall. After adequate exposure is achieved, the orbital periosteum is incised, causing the orbital fat to prolapse into the ethmoid cavity, thereby decompressing the orbit contents. Decompression may be extended to the floor of the orbit if medial decompression alone is insufficient.

Repair of CSF leak: Discontinuity of the anterior skull base, occurring traumatically or spontaneously, may result in CSF rhinorrhea. The defect may be a small crack in the skull base or a larger defect with prolapse of meninges or brain tissue through the defect. The majority of anterior skull base CSF leaks can be closed effectively with endoscopic approaches. Meningoencephaloceles that protrude through a bony skull base defect are reduced with bipolar cautery. After endoscopic visualization of the bony defect, a layered repair is performed using bone or cartilage, followed by a free mucosal graft.

A lumbar subarachnoid drain may be placed prior to starting the case. Fluorescein can be placed through the drain to aid in identifying the leak site during surgery. If fluorescein is used, it must be carefully measured and administered to avoid the neurotoxic effects overdose (accepted dose is 0.1 cc of 10% fluorescein mixed in 10cc of nonbacteriostatic saline, administered slowly over 5 min). Postop, patients remain at bedrest for 1–3 d, typically as an inpatient.

Pituitary Surgery: The application of endoscopic technique to transnasal transphenoidal approaches to the sella provides an excellent panoramic view unavailable with microscopic approaches. Pituitary adenomas, craniopharyngiomas, and other sellar masses are suitable for endoscopic resection. The operating team consists of a neurosurgeon and an otolaryngologist working in concert. The approach is performed by the otolaryngologist, while the tumor resection is performed by the neurosurgeon under endoscopic guidance by the otolaryngologist (“four hands technique”). After performing intraoral greater palatine blocks and topically decongesting the nasal mucosa, the surgeon performing the approach creates bilateral sphenoidotomies. The posterior portion of the septum is then resected, allowing for the subsequent removal of the remainder of the sphenoid rostrum. This provides wide exposure of the sella and parasellar anatomy. The sella is then entered and tumor resection is performed endoscopically.

The dissection of the sella risks injury to the adjacent optic nerve, cavernous sinus, and carotid artery. The anesthesiologist should be prepared to hemodynamically resuscitate the patient in the rare event of a carotid injury. Additional monitoring such as an arterial line may be indicated at the discretion of the anesthesiologist.

A CSF leak may occur if the arachnoid is breached during the tumor resection. This is repaired easily with abdominal fat, fibrin glue, and an absorbable reconstruction plate. In the event of a CSF leak, a lumbar subarachnoid drain may be placed.

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Anesthetic Considerations

Preoperative

The majority of these procedures are performed on an outpatient basis. Patients with extensive polypoid disease may be at risk for substantial (> 400 mL) blood loss. Many of these patients will have received a short preop course of steroid therapy to decrease tissue swelling and reduce bleeding intraop. Routine intraop administration of decadron (8–12 mg iv) to minimize postop edema, makes additional stress-dose of glucocorticoids unnecessary.

Respiratory	Many patients with nasal polyposis have a high incidence of reactive airway disease (up to 26%) as well as a hypersensitivity to aspirin, which can precipitate bronchospasm (triad patients). In these patients, NSAIDs, including ketorolac, should be avoided. In general, ketorolac administration for postop pain relief is not recommended in these patients because it may promote microvascular bleeding. **Tests:** CXR, as indicated by H&P.
Cardiovascular	See Anesthetic Considerations for Nasal Surgery, p. 234.
Premedication	See Anesthetic Considerations for Nasal Surgery, p. 234.

Intraoperative

Anesthetic technique: FESS can be performed under local anesthesia with sedation (MAC) or GA. The essential surgical requirements are similar to those for other types of nasal surgery (see Anesthetic Considerations for Nasal Surgery, p. 234), although more meticulous control of intraop BP is crucial. Local anesthesia offers the advantage of reduced blood loss, but GA is performed more frequently and may be associated with less incidence of surgical complications. Patients with extensive sinus disease, history of multiple previous nasal and sinus surgeries, patients feeling uneasy about being awake, and those with reactive airway disease, or labile HTN may not be candidates for MAC. Use of a FLMA instead of an ETT offers significant advantages (see Introduction, p. 174), including decreasing airway reactivity and improving mucociliary clearance.

Maintaining intraop controlled hypotension (see Introduction, p. 174) is essential for improving surgical visibility and operating conditions. While MAP may largely affect the arterial inflow, other factors including the condition of the vascular network, local mechanisms regulating functional nasal capillary density, and local venous pressure also play a significant role in regulating overall nasal capillary perfusion. As with other types of nasal surgery, these procedures are typically characterized by minimal immediate postop pain 2° submucosal infiltrative local anesthesia used by the surgeon.

Induction	(See Anesthetic Considerations for Nasal Surgery, p. 234). The patient's eyes should be protected in a manner that allows the surgeon to quickly diagnose proptosis in case of inadvertent orbital wall penetration and intraorbital hemorrhage.	
Maintenance	(See Anesthetic Considerations for Nasal Surgery, p. 234). TIVA, with or without nitrous oxide, promotes superior hemodynamic stability and minimizes direct peripheral vasodilation. When additional ↓ BP is required esmolol is preferred over SNP. Breakthrough adrenergic responses occur more frequently with FESS compared to other types of nasal surgery, because many reflexogenic areas (e.g., skull base) cannot be blocked by infiltrative local anesthesia. These responses can be effectively controlled by vasoactive agents or additional boluses of remifentanil (0.5–1.0 mcg/kg iv). The anesthesiologist should frequently observe the video monitor for signs of possible complications - prolapse of periorbital fat (orbital injury), “wash-out” of blood in the surgical field (CSF leak).	
Emergence	(See Anesthetic Considerations for Nasal Surgery, p. 234). If a dural injury has occurred, a smooth extubation is mandatory.	
Blood and fluid requirements	IV: 20 ga × 1 (unilateral FESS) 18 ga × 1 (bilateral FESS) NS/LR @ 3–4 cc/kg/h Blood loss generally 100–150 mL	Blood loss can be substantial in high- risk patients (as described above). Meticulous surgical technique and the use of injectable vasoconstrictors are essential in reducing intraop bleeding. An IV is usually placed at the side where the surgeon is positioned (patient's right upper extremity).
Monitoring	Standard monitors (p. B-1)BP cuff left arm	Prevent BP cuff from inflating against the surgeon's hands during delicate endoscopic manipulation.
Positioning	Table turned 90–180° Head elevated 15–30° and pad pressure points eyes	Patient's arms usually tucked and carefully padded.

Complications	Dysrhythmias Tachycardia	Usually related to use of vasoconstrictor agents; and may present a problem in patients with CAD. Short-acting b-blocker (esmolol 0.5–1.0 mg/kg iv boluses) should be available to blunt these hemodynamic effects.

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Postoperative

Complications	Occult bleeding	Occult postop bleeding may cause the patient to swallow large quantities of blood (↑ aspiration risk), and repacking the nostrils may be required.
Pain management	Fentanyl 25–50 mcg iv prn is usually sufficient.	Occasionally, pain after FESS may be significant. If external approaches to the sinuses were utilized, higher doses of opioids may be necessary.

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External Sinus Surgery

Surgical Considerations

Description: Transfacial approaches to the paranasal sinuses include a transoral sublabial approach to the maxillary sinus and pterygomaxillary space (**Caldwell-Luc**), external ethmoidectomy (often with medial orbitotomy, and/or medial maxillectomy), and osteoplastic approaches to the frontal sinus via a bicoronal incision just behind the hairline. The usual indication for such approaches are resection of malignant and occasionally benign locally extensive tumors such as angiofibroma, especially when for technical reasons (e.g., angle of access or extension into the orbit) it is felt that an endoscopic approach is not indicated. The continued improvement in endoscopic equipment along with increasing surgical experience makes endoscopic resection increasingly more common, safe, and appropriate.

Anterior cranial base surgery: When tumors transgress the anterior cranial base at the cribriform plate and ethmoid roof, an anterior cranial base resection is often done. If the extent of the anticipated dural resection is limited, then the resection can be accomplished endoscopically. In more extensive rsections most surgeons opt for an open approach. Rarely is a central facial incision required as adequate exposure may be obtained via a bicoronal incision *(Print pagebreak 232)* and bifrontal craniotomy. The CSF leak is addressed by a combination of dural substitution (autologous tissue, such as temporalis fascia, bovine pericardium, or manufactured substitutes) and a pericranial-galeal flap. A lumbar subarachnoid drain is sometimes used in this setting.

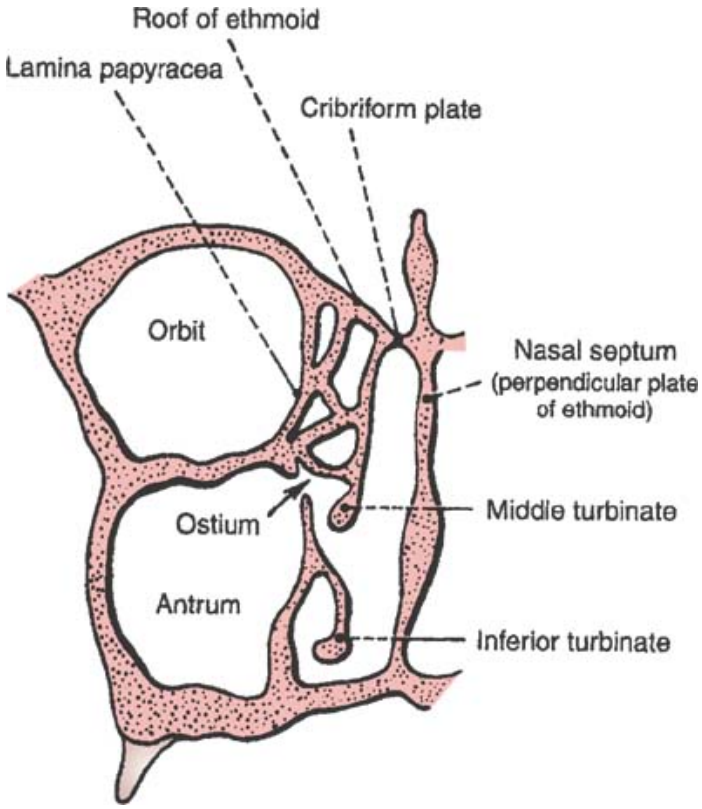

Figure 3-11. Diagrammatic representation of the relationships of the orbit, maxillary antrum, ethmoid labyrinth, and nasal cavity. Note that the medial wall of the ethmoid labyrinth is an upper extension of the attachment of the middle turbinate. The attachment of the upper extension separates the roof of the ethmoid and the cribriform plate. (Reproduced with permission from Montgomery WW: *Surgery of the Upper Respiratory System,* 3rd edition. Williams & Wilkins, 1996.)

Variant approaches: Approaches to the middle cranial base include an orbitozygomatic approach to the infratemporal fossa. The zygomatic arch and part of the zygomatic body is temporarily removed, the temporalis major muscle is transposed inferiorly. The lateral orbital bone with or without the orbital rim may be temporarily removed. A middle fossa craniotomy or craniectomy is usually done. This provides access to the foramen ovale, foramen rotundum, and carotid artery at the skull base, as well as the lateral orbit and superior infratemporal fossa and pterygomaxillary fossa to the pterygoid plates, and, as needed, lateral sphenoid sinus and maxillary sinus. Following tumor resection, part of the temporalis muscle may be used to assist in CSF leak managmement.

Usual preoperative diagnosis: Malignant and some benign tumors

Summary of Procedures

	External Sinus Surgery	Anterior Cranial Base Surgery
Position	Head up 30°, back raised (reduces bleeding).	Also reduces intracranial pressure
Incision	Access to the ethmoid and maxilla is via a 3–4 cm incision midway between the medial canthal ligament and the midline, in the shadow of the nasal bone; a lateral rhinotomy incision is not needed.	A bicoronal incision posterior to the hairline masks the scar. A supplemental facial incision is rarely needed.
Special Instrumentation	Paranasal sinus set; headlight	+ craniotomy set
Unique considerations	Nasal packing	see frontal craniotomy
Antibiotics	Cefazolin 1 gm	
Surgical time	1.5–4 h	5–8 h
EBL	25–300 mL	150–750 mL
Postop care	Same as endoscopic surgery	Same as craniotomy
Mortality	Very rare	Rare

Morbidity	Bleeding: < 5%	Anosmia if bifrontal craniotomy CSF leak: < 2% CVA: <1% Bone flap loss: < 1% Memingitis: < 1% Infection: < 1%
Pain score	4–6	4–6

Patient Population Characteristics

Age range	Children–seniors
Male:Female	1:1
Incidence	Common
Etiology	Malignant tumors, selected benign tumors, occasionally infectious
Associated conditions	Dependent on specific tumor; also see Endoscopic Sinus Surgery

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Anesthetic Considerations

See Anesthetic Considerations following Endoscopic Sinus Surgery, p. 229.

Nasal Surgery (Rhinoplasty, Septoplasty, Septorhinoplasty)

Sam P. Mosr

Surgical Considerations

Description: Nasal surgery is performed for cosmetic and functional restoration of the airway. Functional restoration is usually performed for either congenital or posttraumatic deviations of the septum. The nasal cavity is first cocainized with 4% cocaine-soaked pledgets placed in each nostril for 5–10 min. **Septoplasty** (reconstruction of the nasal septum) usually can be carried out under sedation with local anesthesia, using 1% lidocaine with 1:100,000 epinephrine. **Rhinoplasty-septorhinoplasty** usually is carried out under local anesthesia, but if GA is used, a mouth pack is inserted. Local infiltration with 1% lidocaine with 1:100,000 epinephrine is used to ensure vasoconstriction and to minimize bleeding. Intranasal incisions are made and septal problems corrected. Generally, an anterior hemitransfixion incision is made down to the cartilage, and a submucoperichondrial flap is elevated the length of the septum. A similar flap may be elevated on the contralateral side. Bony deformities are resected with an osteotome, while cartilaginous deformities are either resected or weakened by morselizing, either in situ or after removal, and then replaced. The incision is closed with interrupted absorbable sutures. In **rhinoplasty,** tip remodelling, hump reduction, and bony osteotomies are performed to remodel the nasal contour. Surgery on the inferior turbinates in the form of intramural cautery, resection of turbinate bone, resection of turbinate mucosa or, in some cases, complete turbinectomy may be required to produce a satisfactory airway. After the surgery is complete, both nasal cavities are packed and external splints may be used for rhinoplasty and septorhinoplasty cases. For the plastic surgeon's perspective see Chapter 11.1.

Usual preop diagnosis: Nasal deformity or deviation; deviated septum

Summary of Procedures

Position	Head up 30° to bleeding. Table may be turned 90–180°.
Incision	Intranasal, usually; extended only in open septorhinoplasty

Unique considerations	Nose initially cocainized; use of 1% lidocaine with 1:100,000 epinephrine to ↓ bleeding.
Antibiotics	Cefazolin 1 g iv; routinely used as long as nasal packs are in place.
Surgical time	1–2.5 h
Closing considerations	Nose often packed postop, necessitating oral airway after extubation.
EBL	50–100 mL (excessive blood loss rare)
Postop care	PACU
Mortality	Minimal
Morbidity	Septal perforation: 5% Bleeding: 4% Infection: 4%
Pain score	4–6

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Patient Population Characteristics

Age range	Young teens–young adults
Male:Female	1:1
Incidence	Common
Etiology	Congenital/traumatic septal and/or nasal deviation

Anesthetic Considerations for Nasal Surgery

Preoperative

These cases typically are performed on an outpatient basis. Most of the patients are young and otherwise healthy, but some patients presenting for rhino/septoplasty and turbinate reduction surgery may have OSA with the corresponding implications for intraop management (see p. 256). Older patients may present for major reconstructive nasal surgery following resections of a basal cell carcinoma of the nose. Patients presenting for closed reduction of nasal fractures may have suffered concomitant closed head trauma. If the nose injury is recent, blood may have been swallowed, and the patient should be considered "full stomach."

Respiratory	Some patients may present with a Hx of reactive airway disease; their functional status should be checked and optimized preop. **Tests:** As indicated from H&P.
Cardiovascular	In patients with pre-existing cardiac disease, cocaine use by the surgeon for topical anesthesia or control of bleeding may be contraindicated. **Tests:** ECG in older population; others as indicated from H&P.
Neuro	Psychological disturbances are common in patients presenting for rhinologic surgery.
Premedication	Standard premedication (p. B-1). Sedation should be avoided or used with caution in patients with OSA.

Intraoperative

Anesthetic technique: Septorhinoplasty may be performed under local anesthesia with MAC, although GA is used more commonly. The essential surgical requirements are: patient immobility; clear surgical field (nasal mucosa is extremely vascular); and smooth emergence from anesthesia to avoid postop hemorrhage.

Spontaneous or controlled ventilation can be used intraoperatively, and FLMA is strongly preferred over tracheal intubation (see

above).

Induction	Standard induction with propofol (1–2 mg/kg) is an ideal induction agent because of its short duration and intrinsic antiemetic effect. For GETA, the use of an oral RAE or reinforced ETT will facilitate surgical access. Both ETT and FLMA are usually taped midline.	
Maintenance	All GA techniques (balanced, inhalational, or TIVA) can be used safely, although TIVA is preferred. Propofol infusion (80–150 mcg/kg/min) may offer the advantage of ↓ BP without compensatory ↑ HR, and ↓ PONV. Remifentanil infusion (0.1–0.25 mcg/kg/min) will improve hemodynamic stability and facilitate rapid and smooth emergence. Maintaining moderate degree of ↓ BP is essential.	
Emergence	Antiemetic prophylaxis is obligatory. Emergence from anesthesia after nasal surgery presents significant challenges to the anesthesiologist. Nasal passages may be packed at the end of surgery, making the patients obligate mouth-breathers; the oropharynx should be suctioned carefully. No pressure on the patient's nose with the face mask should be allowed after tracheal extubation or FLMA removal. Full return of airway reflexes should occur before extubation, which must be accomplished smoothly without excessive bucking and coughing. The FLMA is superior to the ETT in this regard.	
Blood and fluid requirements	Blood loss usually minimal IV: 20 ga × 1 NS/LR @ 2–3 cmL/kg/h	Blood loss controlled with surgical hemostasis and topical applications of vasoconstrictor (epinephrine), but also may also include cocaine.
Monitoring	Standard monitors (p. B-1)	
Positioning	Head elevated 15–30° Table turned 90–180° and pad pressure points. eyes	Patient's arms usually tucked in and should be carefully padded. For rhinoplasty, patient's eyes should be protected in a way that would allow for early recognition of an orbital injury (e.g., scleral shields, eye ointment).
Complications	Tachycardia, dysrhythmias	These are usually related to use of vasoconstrictor agents and may present a problem in patients with CAD. Short-acting β-blocker (esmolol, 0.5–1 mcg/kg in boluses) should be available to blunt these hemodynamic effects.

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Postoperative

Complications	Occult bleeding	Occult postop bleeding may caue the patient may swallow large quantities of blood (↑ aspiration risk); and repacking the nostrils may be required.
Pain management	Fentanyl 25–50 mcg iv prn is usually sufficient.	

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Facial Plastic Surgery

Overview: Facial plastic surgery encompasses both reconstructive and aesthetic surgery of the face and neck. Typically, surgeons are trained in either otolaryngology-head & neck surgery/facial plastic surgery or general plastic surgery (see Chapter 11.1) or both. The procedures to be covered in this section are rhinoplasty, rhytidectomy (facelift) and blepharoplasty (eyelid rejuvenation).

Surgical Considerations

Rhinoplasty

Description: Rhinoplasty has traditionally been considered an aesthetic procedure. However, when combined with a septoplasty (rhinoseptoplasty, septorhinoplasty) it is both a functional and aesthetic operation. In some cases, a *(Print pagebreak 236)* purely functional operation (functional rhinoplasty) is performed in order to improve the ability to breathe through the nose. The approach and anesthetic requirements for these can be considered together.

Technique: A septoplasty involves a unilateral intranasal incision along the anterior septum with minor variations in the placement of the incision in the antero-posterior plane. The approaches to rhinoplasty can be intranasal, extranasal or both. Frequently, the external (or “open”) approach to rhinoplasty is employed. The intranasal approach involve incisions along the septum anteriorly and some combination of incisions in the nasal vestibule. The external approach combines these approaches with a midcolumellar incision. In both functional and aesthetic rhinoplasty, the maneuvers include cartilage remodeling or resection, and possibly osteotomies to manipulate the bony pyramid of the nose.

Usual preop diagnosis: For aesthetic patients, the typical preop diagnosis is nasal deformity. However, many patients also complain of nasal obstruction, and some rhinoplasty patients have purely functional concerns. Patients with significant nasal obstruction may have some component of sleep disordered breathing or even OSA. Because of this, patients with nasal obstruction are routinely asked about snoring and daytime somnolence (if they have not already had a diagnostic sleep study).

Preop and intraop preparation: Preoperatively patients receive a nasal decongestant spray (0.05% oxymetazoline spray, 3 doses 10 min. apart) to reduce intraop bleeding. Preop corticosteroid (4–8 mg Decadron iv) and antibiotics (cefazolin, 1 gm iv) are administered. Intraop, we prefer LMA for protection of the airway and esophageal inlet, as some bleeding in the nasopharynx is expected. If an endotracheal tube is used, a throat pack can be placed to reduce blood entrance into the esophagus/stomach. The tube should be secured to the *midline of the lower lip* to avoid distortion of the nose/nasal base.

Postop care: At the end of the procedure, prior to extubation, the surgeon will place an external splint of some type on the nose. Any mask placed on the patient should be done in such a fashion as to not place pressure on the nose. We prefer the transport

oxygen mask be cut off such that no contact occurs. Any Valsalva can result in epistaxis and/or bleeding under the septal or nasal skin flaps. Thus, any manuevers to reduce bucking or coughing during extubation are in order.

Summary of Procedures

Position	Supine
Incision	Intranasal + columella (external rhinoplasty)
Special instrumentation	Headlight
Unique considerations	Nasal obstruction postop
Antibiotics	Often administered preop: cefazolin 1 gm iv
Other Preoperative Meds	Nasal decongestant spray, dexamethasone 4–8 mg iv
Surgical Time	1–3 h
EBL	25–50 cc
Mortality	Minimal
Morbidity	Epistaxis, septal perforation, unsatisfactory aesthetic result
Pain Score	1–4, typically mild

Patient Population Characteristics

Age Range	15+ yr
Male:Female	1:1
Incidence	Common
Etiology	Nasal obstruction, desire for change in nasal form.

(Print pagebreak 237)

Rhytidectomy (Facelift)

Description: Rhytidectomy (facelift) is almost always an aesthetic procedure. In the common vernacular, “facelift” is often used to describe total surgical facial rejuvenation (including eyelids and forehead). Strictly speaking, rhytidectomy involves aesthetic miprovement of the lower half of the face and upper neck. For this reason, some have called it a “necklift” or “lower facelift” to avoid confusion. Perhaps the latter term is more appropriate, as a separate ‘necklift’ procedure does exist. In any event, the anesthetic requirements for these are similar.

Technique: Rhytidectomy incisions are bilateral, extending pre and postauricularly with minor variations. In addition, the surgeon may place a small (0.5–2 cm) incision submentally for access to submental fat and/or platysma muscle. As dissection may be near branches of the facial nerve, *avoidance of muscle relaxants* is required.

Usual preop diagnosis: For aesthetic patients, the typical preop diagnosis is simply desire for reduction in nasolabial and labiomandibular lines, jowling, and neck skin laxity. Patients are typically over the age of 40, and usually in good health. Smoking is a contraindication due to the risk of poor wound healing and/or skin flap necrosis.

Preop and intraop preparation: Preop patients receive corticosteroid (4–8 mg Decadron iv) and antibiotics (cefazolin, 1 gm iv). Intraop, we prefer LMA for protection of the airway and esophageal inlet, though an ETT can be used. The tube should be secured to the *midline of the lower lip* to avoid distortion of the lower face/neck. The tube is prepped in to the field and may be manipulated side-to-side during the procedure as the submental incision is accessed. In addition, the head may be turned about 30–45° to the side opposite the surgeon. Typically, dissection near the branches of the facial nerve is undertaken, and visual monitoring for any twitches is performed by the assistant, thus *avoidance of muscle relaxants is imperative.*

Postop care: At the end of the procedure, prior to patient extubation, the surgeon will place a circumferential external pressure dressing of some kind on the face. Typically, cotton balls soaked in antibiotic ointment are placed in the ears. The patient may have difficulty hearing due to this dressing. Drains may have been placed on each side of the neck. Any Valsalva can result in bleeding under the skin flaps. Hematoma is one of the most common periop complications and requires evacuation. Thus, any maneuvers to

reduce bucking or coughing during extubation are in order.

Summary of Procedures

Position	Supine
Incision	Pre/postauricular and submental
Special instrumentation	Headlight
Unique considerations	Facial nerve is monitored (visually); avoid paralytics
Antibiotics	Often administered preop: cefazolin 1 gm iv
Other preoperative meds	Dexamethasone: 4–8 mg iv
Surgical Time	3 h
EBL	25–50 cc
Mortality	Minimal
Morbidity	Hematoma, facial paralysis, unsatisfactory aesthetic result
Pain Score	1–4, typically mild

Patient Population Characteristics

Age range	40+
Male:Female	1:8
Incidence	Common
Etiology	Desire for change in facial aesthetics
Associated conditions	Other facial aesthetic considerations

(Print pagebreak 238)

Blepharoplasty

(For the plastic surgeon's perspective see Chapter 11.1)

Description: Blepharoplasty (eyelid rejuvenation surgery) is, in the overwhelming marjority of cases, an anesthetic procedure. In some cases, *functional upper lid blepharoplasty* may be performed to reduce visual field obstruction, and is typically covered by insurance. These procedures are often performed under local anesthesia with sedation. However, as they are often combined with other procedures (browlift, facelift), the patients are often under general anesthesia.

Technique: Upper blepharoplasty incisions are placed on curvilinear fashion along the upper eyelid creases with minor variations. The amount of skin to be excised is marked by the surgeon, and local anesthetic with epinephrine is administered. The evolution of upper eyelid blepharoplasty has led to a more conservative approach with less muscle and fat excision being performed. As the procedure becomes more skin-only, many are being performed under local anesthesia as an isolated procedure.

Lower blepharoplasty is generally performed transcutaneously with a subciliary incision or transconjunctivally via the inner portion of the lower eyelid. In the former approach, a small amount of lower lid skin and muscle is typically excised. With both approaches, the surgeon removes or repositions a small amount of the intraorbital fat pockets for the desired aesthetic result.

Usual preop diagnosis: For aesthetic patients, the typical preop diagnosis is simply desire for reduction upper lid skin excess, which may obstruct their vision (see above). In the lower lid, the most common complaint is “puffiness” of the lower eyelid, which is often due to pseudoherniation of orbital fat and descent of the midface fat with age. Patients are typically over the age of 30 and usually in good health.

Preop and intraop preparation: Preop patients receive corticosteroid (4–8 mg Decadron i.v.) and antibiotics (cefazolin, 1 gm iv). Intraop, we prefer LMA for protection of the airway and esophageal inlet. The tube should be secured to the midline of the lower lip to avoid distortion of the lower face/neck.

Postop care: At the end of the procedure, prior to patient extubation, the surgeon will confirm satisfaction with symmetry and aesthetic result. No dressings are used. Any Valsalva can result in bleeding under the skin flaps. More importantly, intraorbital pressure must be avoided as it may result in a serious complication, placing the patient's vision at risk. Thus, any maneuvers to reduce bucking or coughing during extubation are in order.

Summary of Procedures

Position	Supine
Incision	Upper lid crease, lower lid via transconjunctival or transcutaneous approaches
Special instrumentation	None
Unique considerations	None
Antibiotics	Often administered preop: cefazolin 1 gm iv
Other preoperative meds	Dexamethasone: 4–8 mg iv
Surgical Time	1.25 h (upper or lower only); 2 h (both upper and lower)
EBL	< 5 cc
Mortality	Minimal
Morbidity	Asymmetry, dry eye, ectropion, corneal abrasion, blindness (rare)
Pain Score	1–4, typically mild

(Print pagebreak 239)

Patient Population Characteristics

Age range	30+
Male:Female	1:8
Incidence	Common
Etiology	Desire for change in facial aesthetics; in some cases upper blepharoplasty is performed for functional reasons
Associated conditions	Other facial aesthetic considerations

Anesthetic Considerations

(see Anesthetic Considerations for Office based procedures and Anesthetic Considerations for Facial Cosmetic Surgery p. 858)

Otology and Neurotology

Surgical Considerations

Otologic Surgery: Otologic surgery is indicated for a spectrum of disorders, including traumatic, developmental, infectious, and neoplastic disease. Procedures involving the external auditory canal, middle ear, and inner ear will be considered in this section. Surgery confined to the pinna or that requiring craniotomy is considered elsewhere.

The temporal bone is as complex as any region of human anatomy (Fig. 3-12 and Fig. 3-13). Multiple vital neurovascular structures interrelate in a small confined space. These include the organs of hearing and balance, the facial nerve, the carotid artery, jugular vein, and the delicate mechanisms of the middle ear. The density and complexity of the anatomy dictate the delicate nature of otologic procedures and hence many of its anesthetic requirements. Most procedures are either performed via a transcanal approach (through the natural meatus of the external ear), a retroauricular incision, or a combination of the two.

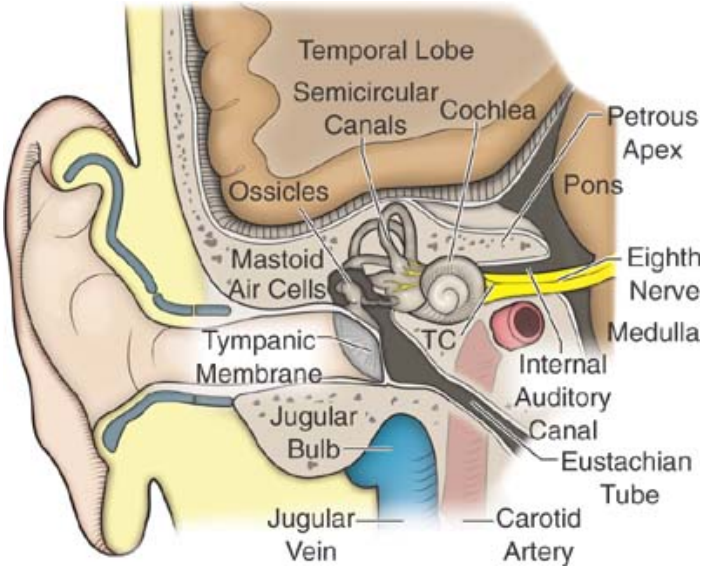

Figure 3-12. Coronal diagram of right ear

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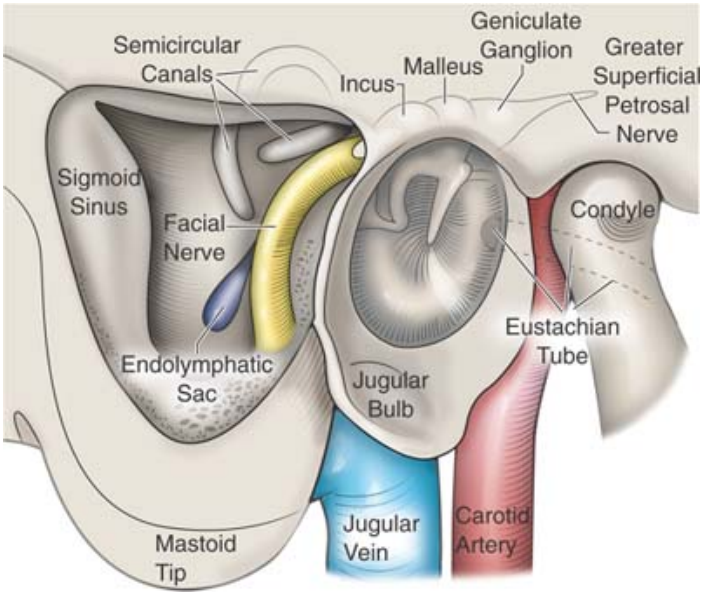

Figure 3-13. Lateral diagram of right ear

Many otologic procedures are undertaken to control recurrent or chronic ear infections (otomastoiditis). The simplest of these is the **myringotomy**, in which the tympanic membrane (TM) is incised through the ear canal, and the middle ear contents are aspirated. In most cases, a myringotomy tube is also placed to maintain middle ear aeration and drainage. This procedure usually takes just a few minutes, and is performed under mask GA. A myringoplasty involves the repair of a persistent TM perforation, and usually involves placement of autologous tissues as a patch to enable healing. When combined with repair of chronic middle ear changes, the procedure is termed a tympanoplasty.

The mastoid is an area of bone and air spaces situated behind the middle ear and external auditory canal. The removal of this bone, through a **simple mastoidectomy**, enables the removal of loculated infection, diseased tissue, and provides access to additional anatomy. This is often combined with tympanoplasty **(tympanomastoidectomy)** to address the changes from chronic infection. This is the standard surgical approach to resect a **cholesteatoma**, which is a keratin-containing epithelial cyst originating from the TM that has grown into the middle ear and mastoid cavity. When the posterior bony wall of the external auditory canal is left in place to keep the mastoid cavity anatomically distinct from the external auditory canal, the procedure is called a **canal-wall-up tympanomastoidectomy**. In contrast, for more aggressive disease, the partition between the external canal and the mastoid cavity can be removed, thereby exteriorizing the mastoid cavity in what is termed a **canal-wall-down tympanomastoidectomy**. During this procedure, the external auditory canal meatus should also be enlarged to accommodate the resulting mastoid bowl. The complete removal of mastoid and middle ear contents is sometimes referred to as a **radical mastoidectomy**. Tympanomastoid

surgery is usually performed under GA, and may take several hours to complete.

Surgery is often performed to improve the mechanical conduction of sound vibrations through the middle ear into the inner ear ("conductive hearing loss"). If the cause of the mechanical dysfunction is not clear, the surgeon may perform an **exploratory tympanotomy**, during which the TM is elevated and the middle ear structures are inspected and palpated to reveal deficits in their function. **Ossicular chain reconstruction** involves rebuilding or replacing the bones of hearing (malleus, incus, and stapes) with either the patient's own tissues or with aloplastic prostheses. Otosclerosis is a disorder characterized by the progressive fixation of the stapes to the surrounding bone, resulting in hearing loss. One option for affected patients is to perform a **stapedectomy** (or stapedotomy) in which the stapes is replaced by a prosthesis to restore more normal continuity of sound conduction. This procedure can be performed either under local or general anesthesia. It involves extreme accuracy for success, and can be one of the most challenging cases for the otologic surgeon.

Cochlear implantation is an option to address severe or profound inner ear hearing loss ("sensorineural hearing loss"). During implantation, a retroauricular incision and mastoidectomy are performed to provide a pathway for *(Print pagebreak 241)* device placement into the inner ear. A receiver-stimulator is placed under the skin behind the ear, and a flexible electrode array is threaded into the turns of the cochlea to later be used to stimulate the cochlear nerve directly, and thereby bypass the dysfunctional inner ear. The devices are activated usually several weeks following placement, at which time hearing function is expected to increase.

A number of procedures address disorders specifically confined to the external auditory canal. Patients may develop extra bone growths (exostoses) in the ear canal that obstruct the canal. **Exostoses resection** can be performed through a retroauricular incision or via a transcanal approach if the disease is limited. Patients may lack an ear canal (canal atresia) as the result of a congenital disorder, from chronic inflammation, or post-traumatic scarring. In such patients, a **canalplasty**, involving obstructing skin, bone, and scar can be performed. Similarly, patients may require the resection of a number of neoplastic lesions of the ear canal, most commonly of cutaneous origin. Such resections may require additional resection of adjacent tissues affected by the neoplastic process. A skin graft may be used to reconstruct the external auditory canal. This may be harvested from the retroauricular region, the inner aspect of the arm, or from the hip or thigh.

The majority of otologic surgery requires the use of a surgical microscope. The presence of the microscope has a number of implications for anesthesia. Often, the OR table is turned 180°. Of critical importance is that the patient remain entirely motionless. Any adjustment of equipment or position can have profound consequences during microdissection. Therefore, the surgeon must be made aware of any plans that may result in patient motion–even those that would otherwise seem insignificant. During microsurgery, even small amounts of bleeding can have dramatic implications, thus maintenance of a stable low blood pressure is useful.

One common theme to otologic procedures is the need to identify and preserve the **facial nerve.** The 7th cranial nerve winds its way through the temporal bone from its origin in the brainstem to the stylomastoid foramen. It passes through the middle ear, and is at risk during almost all otologic procedures. The use of an EMG-based neural monitor is now commonplace to assess neural function. The monitor will not function if paralytic agents are in use, and their untimely use can prevent the surgeon from receiving critical warnings regarding nerve activity. As a standard rule, always check with the surgeon prior to the administration of any paralytic agents during otologic procedures.

Although the internal carotid artery and jugular bulb pass through the middle ear, significant vascular injury is quite rare. Most if not all bleeding can be readily controlled with packing in the surgical field. The use of absorbable gelatin sponges (e.g., Gelfoam) is routine to hold reconstructive materials in place, and also can help with hemostasis. Venous injury, such as laceration of the sigmoid sinus during mastoidectomy, can usually be controlled using bone wax or with other hemostatic materials (e.g., Surgicel) held with pressure against the site of bleeding. In the case of a large venous injury, a **venous air embolism** can potentially result, and timely communication between the surgical and anesthesia teams can facilitate its identification and treatment. More severe arterial injury, may require additional neuroradiologic or neurosurgical intervention. Even in these rare instances, hemodynamically significant blood loss can usually be avoided with prompt and secure packing.

The temporal bone abuts the dura of the middle fossa above and the posterior fossa behind. Rarely, transgression of the dura can result either as the result of pathology or from dissection of adjacent tissues. When this occurs, the surgeon can usually close the leak using autologous tissues. The surgeon may request administration of a Valsalva maneuver to check the integrity of the repair.

Usual preop diagnoses: Acute or chronic otitis media, cholesteatoma, hearing loss (conductive or sensorineural), otosclerosis, aural atresia (acquired or congenital), tympanic membrane perforation, temporal bone fracture, temporal bone neoplasm.

Summary of Procedures

Position	Supine
Incision	Postauricular or transcanal
Special instrumentation	Binocular surgical microscope, otologic micro-instruments, otologic drill, laser
Unique considerations	Complex microanatomy, no paralytics given need for facial nerve monitoring, Possible avoidance of nitrous oxide
Antibiotics	Often administered preoperatively
Surgical Time	< 1 h to > 4 h
EBL	Usually minimal
Mortality	Minimal
Morbidity	Infection, hearing loss, vertigo, facial nerve dysfunction, spinal fluid leak
Pain Score	1–6, typically mild

(Print pagebreak 242)

Patient Population Characteristics

Age range	all ages
Male:Female	1:1
Incidence	Common
Etiology	Infectious, traumatic, congenital, neoplastic
Associated conditions	Heavy loss, head trauma

Anesthetic Considerations

(See Anesthetic Considerations following Maxillectomy, p. 211.)

Suggested Readings

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(Print pagebreak 243)

Neurotological Skull Base Surgery

Surgical Considerations

The skull base refers to the floor of the cranial cavity and can be divided into anterior, middle, and posterior fossae. It is formed by the frontal, ethmoid, sphenoid, temporal, and occipital bones. Neurotologists primarily deal with lesions in the posterior fossa which is bordered by the clivus (anterior), temporal bone (lateral), and occipital bone (posterior). An axial view of the skull identifying these structures is shown in Fig. 3-14.

The term **skull base surgery** is a misnomer as the majority of lesions treated are located adjacent to the brainstem and not intrinsic to the skull base itself. Removal of the skull base bone allows exposure to these lesions while minimizing cerebral and cerebellar retraction.

The cerebellopontine angle (CPA) is a fluid-filled space containing the facial nerve (VII) and vestibulocochlear nerve (VIII) coursing laterally towards the internal auditory canal. A depiction of the CPA and associated cranial nerves is shown in Fig. 3-15. This is one of the most commonly approached areas in skull base surgery and lesions include *(Print pagebreak 244)* vestibular schwannomas (91.3%), meningiomas (3.1%), epidermoids (2.4%), nonvestibular schwannomas (1.4%), and arachnoid cysts (0.5%).

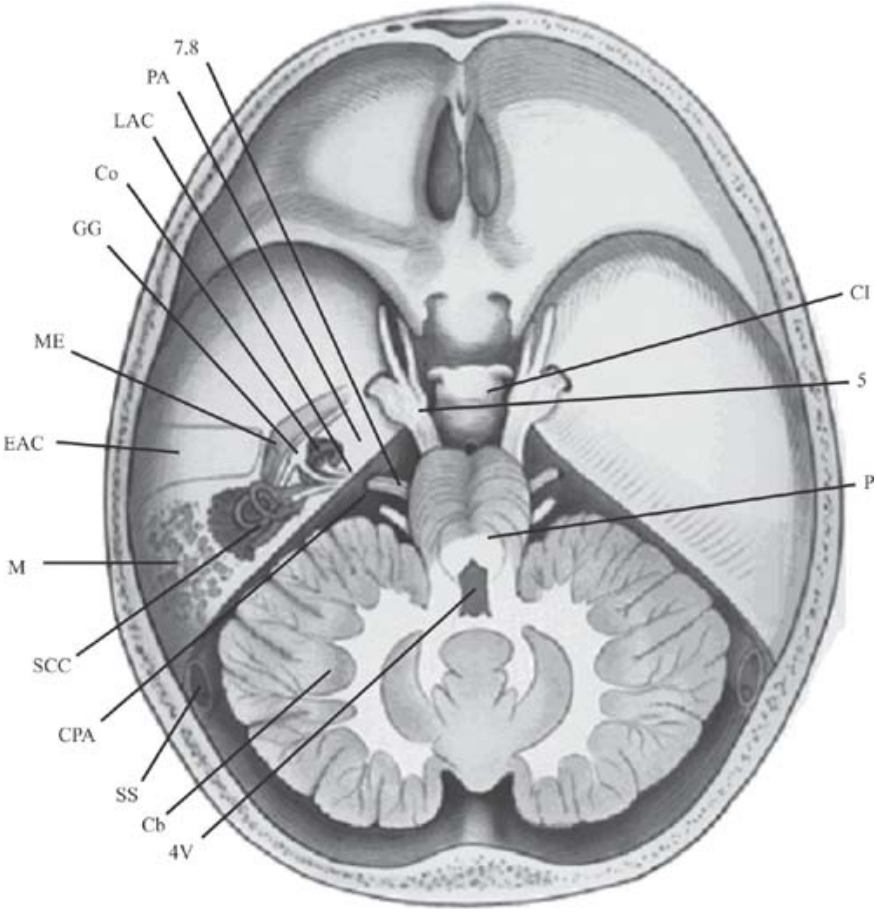

Figure 3-14. An axial view of the skull through the level of the internal auditory canal and cerebellopontine angle. *5*, Trigeminal nerve; *7*, facial nerve; *8*, audiovestibular nerve; *PA*, petrous apex; *IAC*, internal auditory canal; *Co*, cochlea; *GG*, geniculate ganglion of the facial nerve; *ME*, middle ear; *EAC*, external auditory canal; *M*, mastoid air cell system; *SCC*, semicircular canals; *CPA*, cerebellopontine angle; *SS*, sigmoid sinus; *4V*, 4th ventricle; *Cl*, clivus; *P*, pons; *Cb*, cerebellum. Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery*. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.

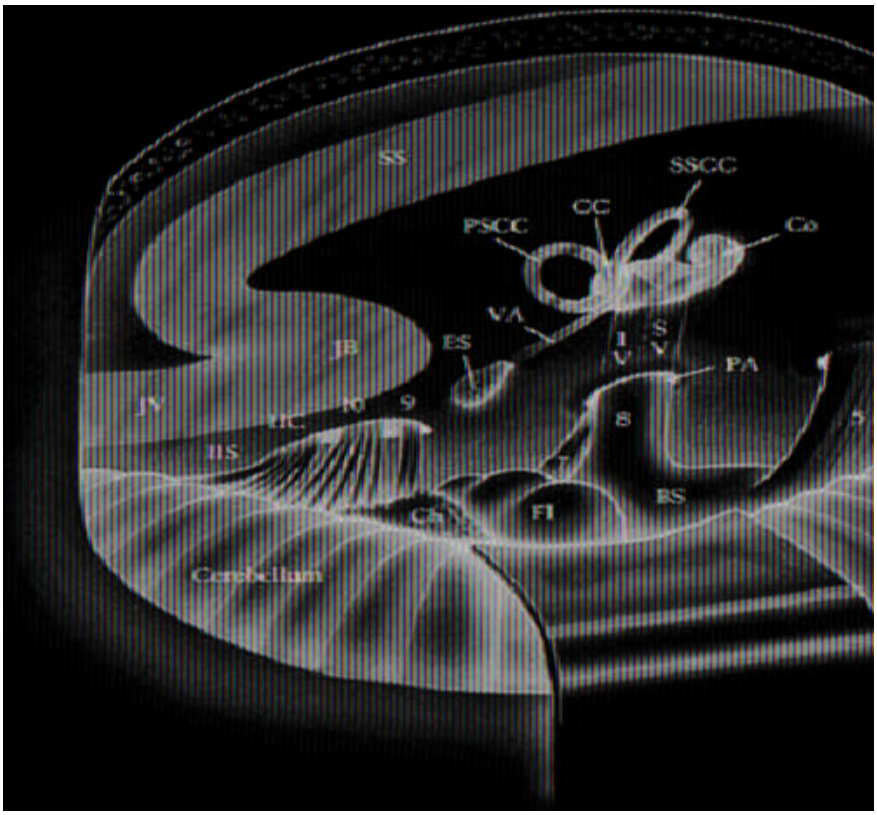

Figure 3-15. Anatomical relationships of the cerebellopontine angle shown through a retrosigmoid posterior fossa craniotomy. *JV*, jugular vein; *JB*, jugular bulb; SS, sigmoid sinus; *11s*, spinal component of the accessory nerve; *11c*, cranial component of the accessory nerve; *10*, vagus nerve; *9*, glossopharyngeal nerve; *Ch*, choroid plexus emanating from the lateral recess of the 4th ventricle; *Fl*, flocculus; *BS*, brainstem surface (pons); *5*, trigeminal nerve; *7*, facial nerve; *8*, audiovestibular nerve; *PA*, porus acousticus; *IV*, inferior vestibular nerve; *SV*, superior vestibular nerve; *ES*, endolymphatic sac; *VA*, vestibular aqueduct; *PSCC*, posterior semicircular canal; *CC*, common crus; *SSCC*, superior semicircular canal; *Co*, cochlea. (Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery*. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

Vestibular schwannomas (also known as **acoustic neuromas**) are removed via three surgical approaches: translabyrinthine, retrosigmoid, and middle fossa. The translabyrinthine approach uses a postauricular incision to access the temporal bone (Fig. 3-16). Retraction of the temporal lobe and cerebellum is minimized as the entire mastoid and labyrinth are removed to create access. This approach results in complete sensorineural hearing loss and is most commonly used in patients with large tumors and/or non-serviceable hearing. Patients with serviceable hearing may elect for a hearing conservation approach for their tumors (retrosigmoid or middle fossa). The retrosigmoid approach uses a more posterior craniotomy between the sigmoid and transverse sinuses. The cerebellum is retracted posterior away from the petrous face of the temporal bone (Fig. 3-15). Disadvantages include the increased incidence of postop headache and the need for rigid skull fixation (e.g., Mayfield). The middle fossa approach places the craniotomy above the ear and requires retraction of the temporal lobe (Fig. 3-17). This approach has the highest rate of hearing conservation, but can only be used in smaller tumors without increasing the risk of postop facial palsy.

Another commonly approached area is the jugular foramen which lies at the junction of the petrous apex and occipital bone. This foramen connects the intracranial compartment to the neck and contains the glossopharyngeal nerve *(Print pagebreak 245)* (IX), vagus nerve (X), accessory nerve (XI), jugular bulb, and inferior petrosal sinus. The most common tumors in this area are paragangliomas. Paragangliomas are divided into two groups: (a) adrenal paragangliomas (also known as pheochromocytomas) and (b) extraadrenal paragangliomas located in the abdomen, chest, and head and neck regions. In the jugular foramen, these tumors are often referred to as **glomus jugulare**. Less common pathologies in this area include meningiomas and lower cranial nerve schwannomas.

Figure 3-16. Typical left translabyrinthine posterior fossa craniotomy exposure of a medium-sized tumor. Inferiorly, the lower cranial nerves **(A)** are visible and the jugular bulb **(B)** has been identified. Troughs have been drilled above and below the IAC, and the dura **(C)** has been reflected off the tumor surface. The sigmoid sinus **(D)** and cerebellum are gently retracted posteriorly. The trigeminal nerve **(E)** is located superiorly. The facial nerve **(F)** takes a variable and often serpentine course across the medial side of the tumor. (Republished with permission from Jackler RK: Atlas of Neurotology and Skull Base Surgery. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

Glomus jugulare tumors are highly vascular and patients undergo preop embolization before surgery. Two to 4 U of autologous or crossmatched blood are kept available depending on the size and extent of the tumor. Large-bore ivs should be placed in case rapid transfusion is needed. In addition to a lateral craniotomy similar to the translabyrinthine approach, a limited neck dissection is performed in order to gain vascular control of the jugular vein and carotid artery. This transjugular craniotomy exposes the entire jugular fossa and involves resection of the involved sigmoid sinus and jugular vein (Fig. 3-18). New lower cranial nerve deficits occur *(Print pagebreak 246)* in 25–50% of patients, therefore appropriate airway and aspiration precautions must be taken. Rehabilitation often involves speech therapy and vocal cord medialization. Tracheotomy and PEG tube placement are rarely necessary.

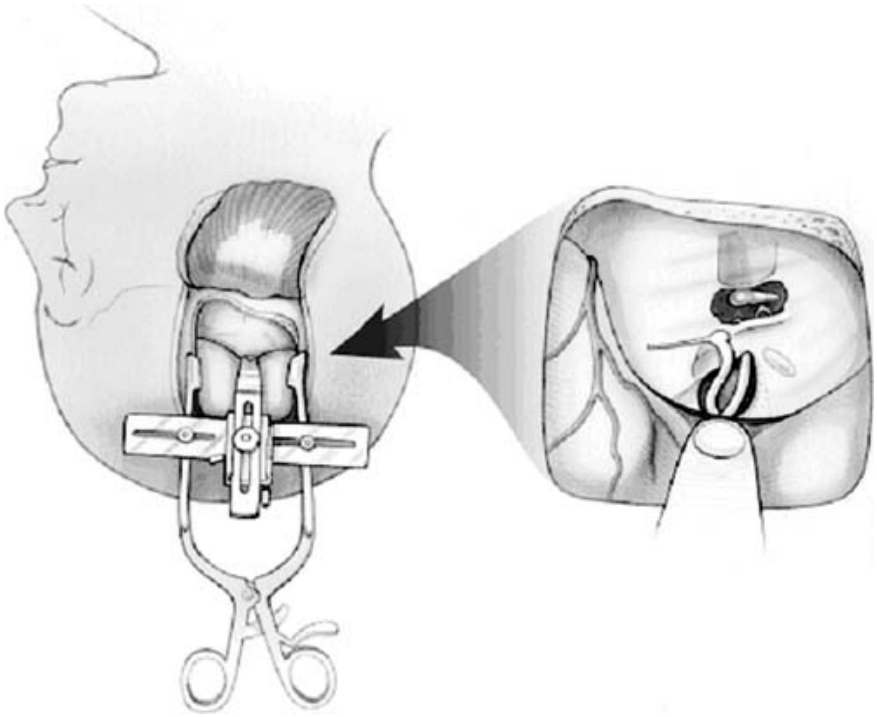

Figure 3-17. Middle fossa exposure of a small right-sided tumor. The retractor is engaged over the posterior lip of the petrous bone and retracts the temporal lobe. Bone has been removed around the IAC, and the dura has been opened to expose the tumor. The facial nerve typically courses across the superior aspect of the tumor surface. (Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery*. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

In all of the preceding craniotomies, the patient is turned 180° away from the anesthesiologist. This allows room for the operating microscope, scrub assistant, and surgeon to all be placed around the head of the patient (Figs. 3-19 and 3-20). The patient's head is turned to one side to allow exposure of the lateral cranium and neck. In the retrosigmoid craniotomy, a Mayfield is used for rigid skull fixation. As lateral table rotation is often used during these cases, three straps should be used to secure the patient and the contralateral arm should be well padded in order to avoid ulnar neuropathy. Neurophysiologic monitoring (EMG, auditory brainstem reponses, and SSEPs) is used throughout the case; therefore, muscle relaxants should be avoided.

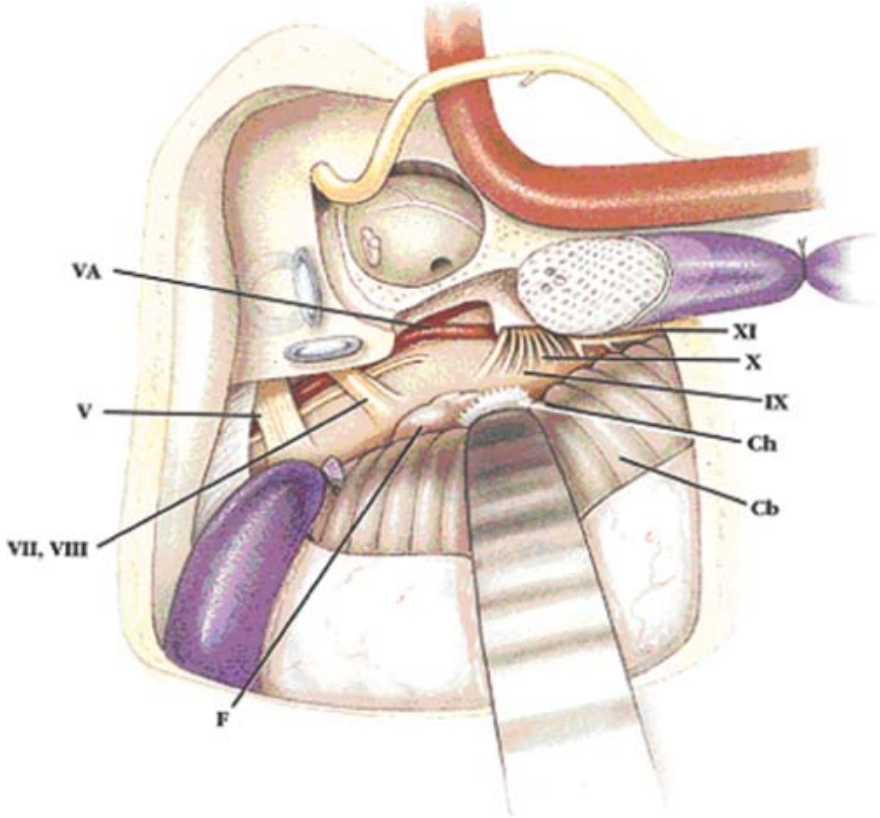

Figure 3-18. Transjugular craniotomy illustrating the degree of intracranial exposure obtained following resection of the sigmoid-jugular system and wide opening of the posterior fossa dura. Note the multiple small rootlets of the lowers cranial nerves emanating from the lateral surface of the medulla. In contrast to extracranial procedures, the sigmoid sinus is ligated proximally rather than packed extralumenally. While this illustration depicts anterior rerouting of the facial nerve, this is not necessary in most intracranial jugular foramen tumors. The sigmoid sinus has been controlled with a suture ligature just distal to the transverse-sigmoid junction. (VA–vertebral artery, F–flocculus, Ch–choroid, Cb–cerebellum, V–trigeminal nerve, VII–facial nerve, VIII–audiovestibular nerve, IX–glossopharyngeal nerve, X–vagus nerve, XI–accessory nerve). (Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery.* Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

Stimulation of the trigeminal or vagus nerves can cause bradycardia; therefore, the surgeon should be informed of any unexpected physiologic changes occurring with the patient. Stable low blood pressure is useful in controlling slow bleeding in the surgical field. Significant hemodynamic blood loss is rare and can usually be controlled with secure packing. Large venous injuries may result in air embolism and arterial injuries may require the assistance of interventional neuroradiology. Having 1 U of cross-matched blood available is prudent in most craniotomies, whereas 2–4 U may be required in glomus jugulare cases. Cerebrospinal fluid (CSF) leaks are controlled using an abdominal fat graft.

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Usual Preop Diagnoses: Vestibular schwannoma (acoustic neuroma); meningioma; paraganglioma (glomus jugulare); lower cranial nerve schwannoma; epidermoid cyst; arachnoid cyst; cholesterol granuloma; chondrosarcoma; chordoma

Summary of Procedures

Position	Supine, turned 180° from anesthesia (Figs 3-19 and 3-20). Three straps to secure patient and arms well padded. Mayfield rigid fixation in retrosigmoid craniotomies
Incision	Postauricular or temporal with possible extension into neck depending on approach.
Special instrumentation	Microscope, neurophysiologic monitoring team, ultrasonic aspirator, neck dissection and vascular instruments (transjugular), middle fossa retractor (middle fossa), otologic

	drill
Antibiotics	Ceftriaxone 2 g iv or vancomycin 1 g iv for CSF penetration
Procedure Time	4–12 h
Closing Considerations	Minimize coughing and ↑ICP. Abdominal fat often harvested for CSF leak closure. Head dressing may be placed.
EBL	100–1000 mL depending on approach and tumor. One unit of cross-matched or autologous blood for craniotomies (2–4 U for glomus jugulare tumors) should be available.
Postop Care	Extubation in majority of cases. Monitoring in ICU for the first night. Minimal sedatives to allow neurological monitoring. Airway and aspiration precautions in patients with possible lower cranial nerve palsies.
Mortality	Rare
Morbidity	Hearing loss (approach dependent)Vertigo Facial nerve dysfunction Hoarseness Aspiration CSF leak Meningitis Stroke (rare)
Pain Score	4–6

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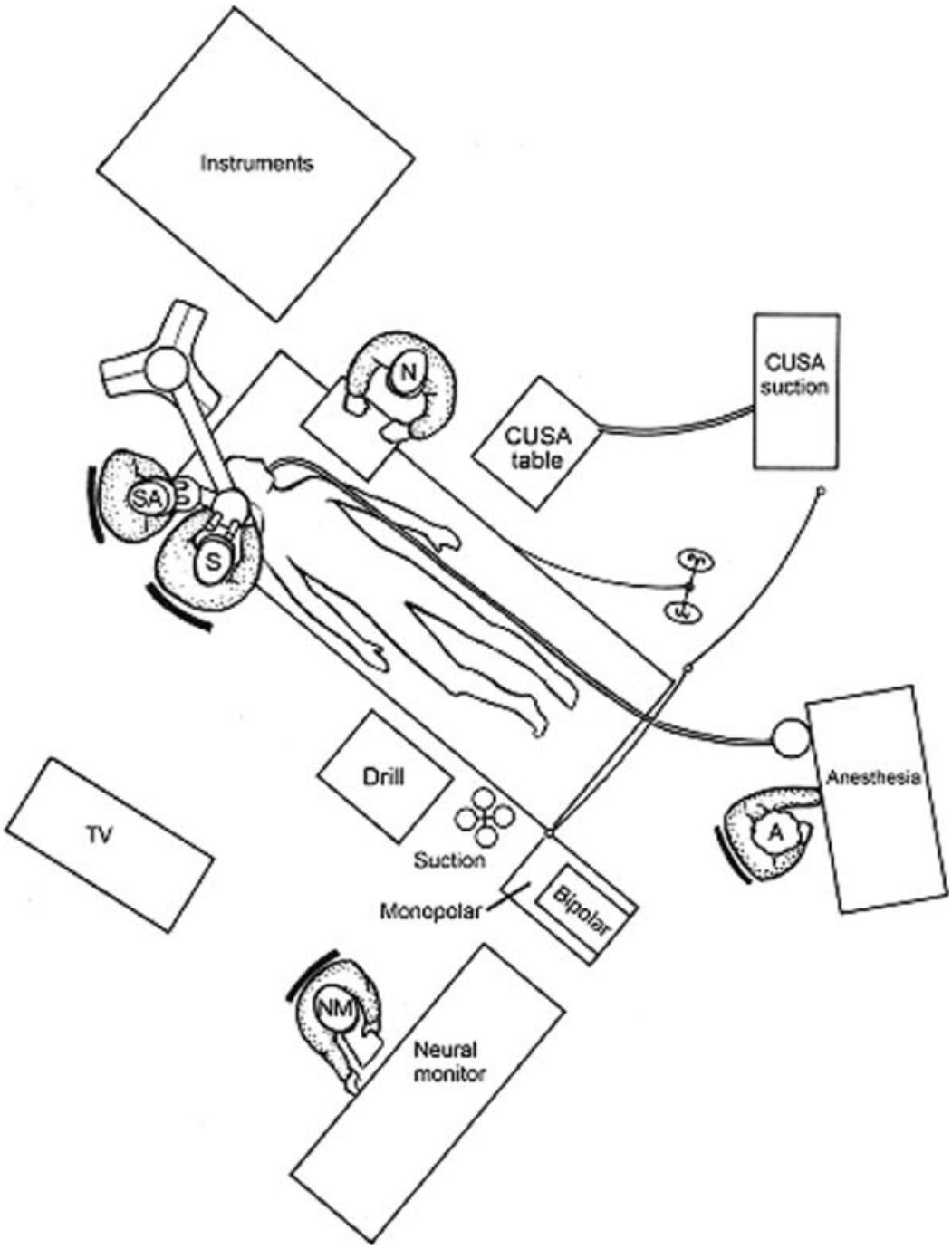

Figure 3-19. Operating room setup for posterior fossa craniotomy (translabyrinthine, retrosigmoid, and transjugular). (Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery*. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

Patient Population Characteristics

Age range	5th to 6th decades for most pathology Younger patients in tumors associated with neurofibromatosis (NF-2)
Male:Female	1:1 for vestibular schwannoma
Incidence	1/100,000
Etiology	Neoplastic
Associated conditions	Hearing loss (use assistive devices when possible), vertigo, lower cranial nerve dysfunction (aspiration precautions), neurofibromatosis

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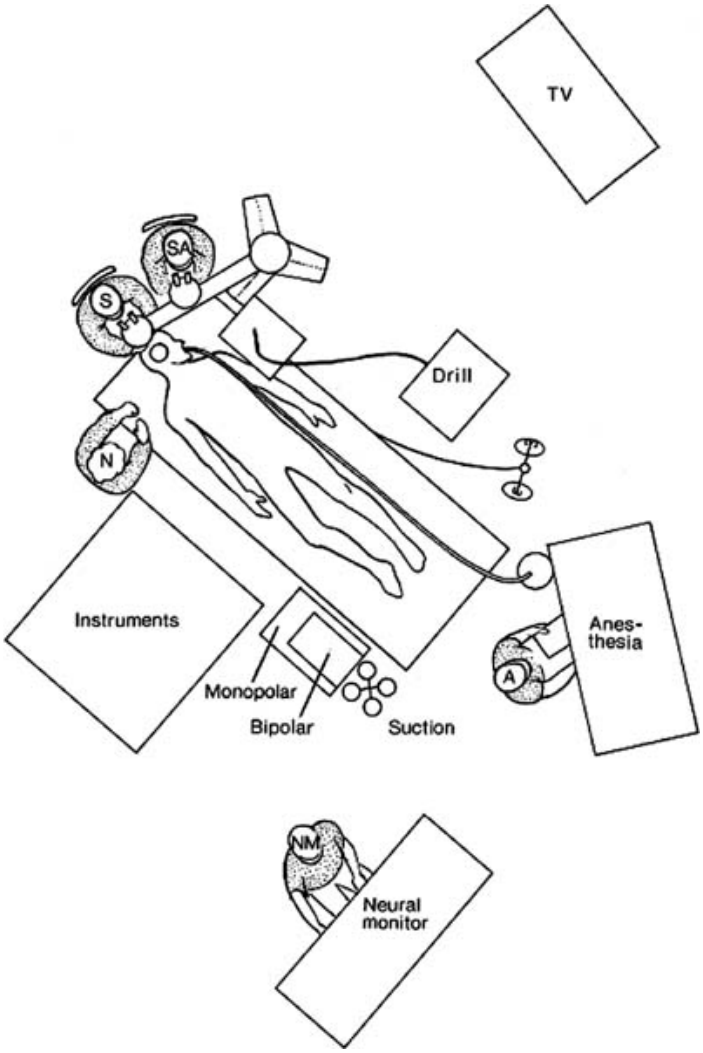

Figure 3-20. Operating room setup for middle fossa craniotomy. (Republished with permission from Jackler RK: *Atlas of Neurotology and Skull Base Surgery*. Mosby, St. Louis: 1996. Copyright Dr. R. K. Jackler © 2007.)

Anesthetic Considerations

(See Anesthetic Considerations for Maxillectomy, p. 211)

Suggested Readings

1. Brackmann DE, Bartels LJ: Rare tumors of the cerebellopontine angle. *Otolaryngol Head Neck Surg* 1980; 88:555–9.

2. Lustig LR, Jackler RK: The variable relationship between the lower cranial nerves and jugular foramen tumors: implications for neural preservation. *Am J Otol* 1996; 17:658–68.

Reconstructive Surgery for Sleep-Disordered Breathing

Surgical Considerations

Robert B. Riley

Nelson B. Powell
Donald Sesso

Description: The surgical approaches to the upper airway attempt to relieve obstruction occurring most commonly at the level of the palate, base of tongue, or pharynx. These fall into three categories: (a) classic procedures *(Print pagebreak 250)* that directly enlarge the upper airway; (b) specialized procedures that directly enlarge the upper airway; and (c) tracheotomy to bypass the pharyngeal portion of the upper airway. The surgeon performs a preop evaluation, including complete head and neck exam, fiber optic examination of the upper airway, and cephalometric radiographs. This, together with the results of the polysomnogram, will enable the surgeon to determine what levels of the airway need to be surgically modified. Individuals with severe obstruction may require a multistage approach to treatment.

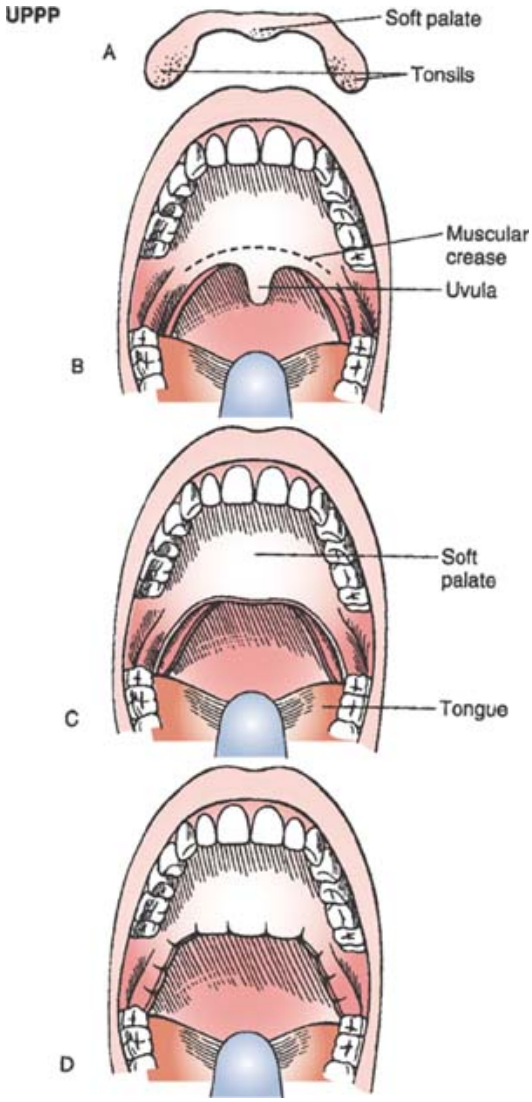

Figure 3-21. Uvulopalatopharyngoplasty (UPPP): **(A&B)** tonsils and redundant soft palate are excised; **(C)** mucosal flaps are prepared for closure; **(D)** the soft palate is closed to itself, and the anterior and posterior tonsillar pillars are sutured to each other.

Uvulopalatopharyngoplasty (UPPP) (Fig. 3-21) is a procedure that removes a rim of the soft palate, including the uvula. This shortens and tightens this tissue, thus preventing collapse during sleep. The tonsils, if present, are removed. The muscular crease of the palate is used as a landmark to prevent overly aggressive resection, which could → velopharyngeal insufficiency (VPI), an uncommon but serious complication. The wound is then closed, using interrupted absorbable sutures.

Uvulopalatal flap (UPF) (Fig. 3-22) is a variation of UPPP, used for treating palatal obstruction. Rather than excising a rim of the soft palate, the mucosa of the anterior aspect of the uvula is removed, along with a corresponding area of *(Print pagebreak 251)* the soft palate. The uvula is then reflected superiorly and sutured into place with absorbable suture. This procedure may be done in combination with a tonsillectomy. UPF is theoretically reversible if signs of VPI become evident. UPF also may be somewhat less painful than UPPP.

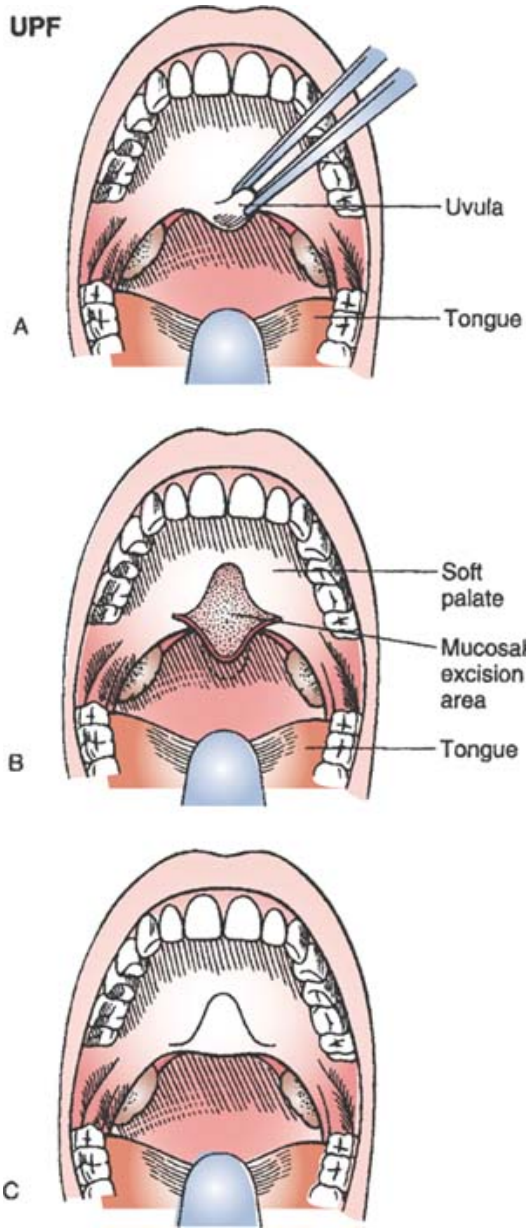

Figure 3-22. Uvulopalatal flap (UPF): **(A)** uvula is reflected back to the hard palate to identify the muscular crease; **(B)** mucosa on the oral side of the uvula and soft palate are removed, and part of the uvula is amputated; **(C)** mucosal incisions are closed with absorbable suture.

Uvulopalatopharyngoglossoplasty (UPPGP) is a rarely performed, intraoral procedure incorporating a modified UPPP with limited resection of the base of tongue for both retropalatal and retrolingual collapse.

Laser midline glossectomy (LMG) is used to enlarge the retrolingual airway by excision of 2.5 cm × 5 cm of midline tongue tissue through an intraoral approach. This also may require lingual tonsillectomy, reduction of the aryepiglottic folds, and partial epiglottectomy (Fig. 3-23). LMG usually is combined with a tracheotomy for airway protection.

Lingualplasty (LP) is the same procedure as LMG, except that additional tongue tissue is extirpated posteriorly and laterally to that portion removed by LMG (Fig. 3-23). It is usually combined with a tracheotomy (see below) for airway protection.

Inferior sagittal mandibular osteotomy and genioglossal advancement (MOGA) (Fig. 3-24) is an intraoral approach designed to enlarge the retrolingual area. This procedure relies on the firm attachment of the *(Print pagebreak 252)* genioglossus muscle to the geniotubercle, a bony protuberance on the medial (lingual) aspect of the mandible. A mucosal incision is made intraorally and soft tissue, including the mentalis muscle, is elevated off the mandible. Osteotomies, which include the geniotubercle on the inner cortex, are then performed. The segment is advanced and rotated to lock it in place. The outer cortex is removed and the fragment is fixated to the inferior mandible with a titanium screw. The advancement is limited by the width of the mandible and laxity in the genioglossus muscle.

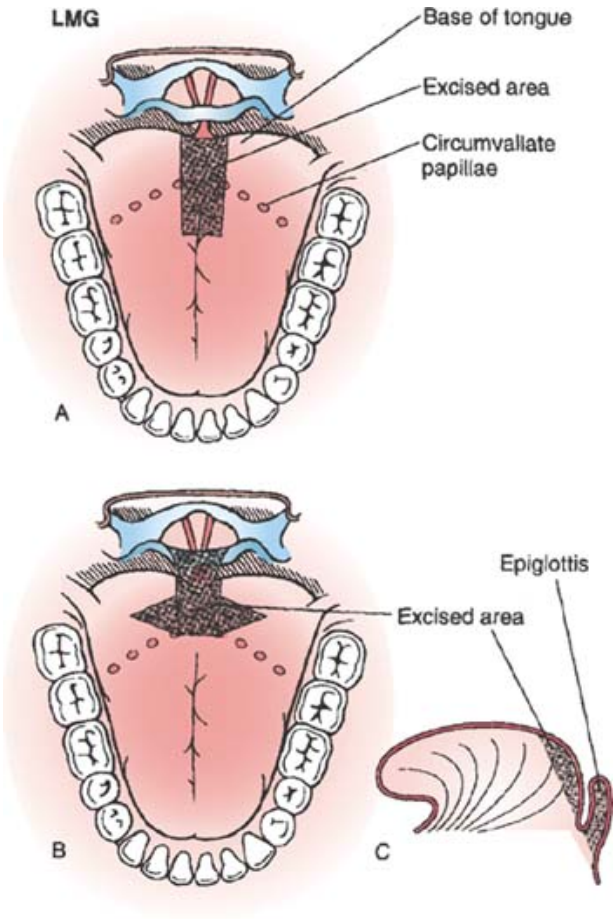

Figure 3-23. LMG/lingualplasty technique: **(A)** Excision of a midline segment of the base of the tongue is performed with a laser or electrocautery; this excision occasionally is carried lateral. **(B)** The remaining tongue muscle edges are reapproximated with absorbable suture. **(C)** Lateral view of tongue.

Hyoid myotomy and suspension (HM) is a retrolingual procedure that alleviates obstruction by redundant lateral pharyngeal tissue or a retrodisplaced epiglottis. A horizontal cervical incision above the hyoid bone is performed, and the dissection is carried down to the suprahyoid musculature. The midline hyoid bone is isolated and then advanced over the thyroid ala. It is then immobilized with two medial and two lateral permanent sutures (Fig. 3-25). The wound is closed, a drain placed, and a pressure dressing applied.

Maxillomandibular osteotomy and advancement (MMO) prevents retropalatal collapse through stenting of the superior pharyngeal muscles and widening of the nasopharyngeal inlet. It also minimizes retrolingual obstruction by placing the genioglossus muscle under tension, providing more room in the oral cavity for soft tissues, and stenting the lateral pharyngeal wall. An outer-table cranial bone graft usually is performed, along with arch-bar placement (or orthodontic banding in an outpatient setting) prior to the osteotomies. A LeFort I maxillary osteotomy and bilateral sagittal-split mandibular osteotomy are performed. The skeletal arches are advanced forward 10 mm and secured with the aid of a methylmethacrylate dental splint (Fig. 3-26). Immobilization with wires, plates and screws follows, then wound closure, intermaxillary fixation, and pressure dressing application. *(Print pagebreak 253) (Print pagebreak 254)* This procedure usually is performed if previous upper airway procedures have not completely relieved the sleep-related obstruction.

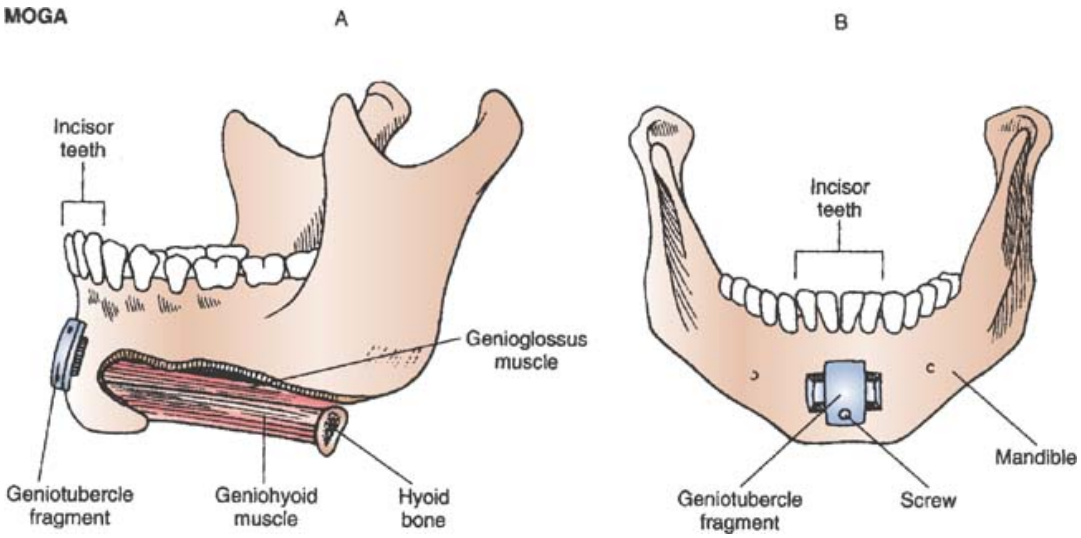

Figure 3-24. The mandibular osteotomy and genioglossus advancement (MOGA) technique: **(A)** Lateral view. **(B)** Anterior view. A rectangular anterior mandibular osteotomy below the incisor teeth is advanced, rotated, and immobilized.

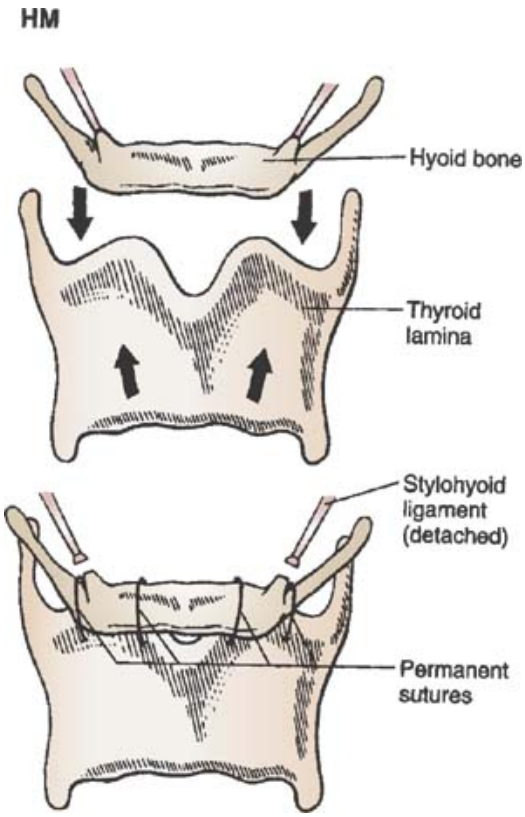

Figure 3-25. The hyoid myotomy (HM) and suspension technique: the hyoid is advanced over the thyroid lamina and immobilized.

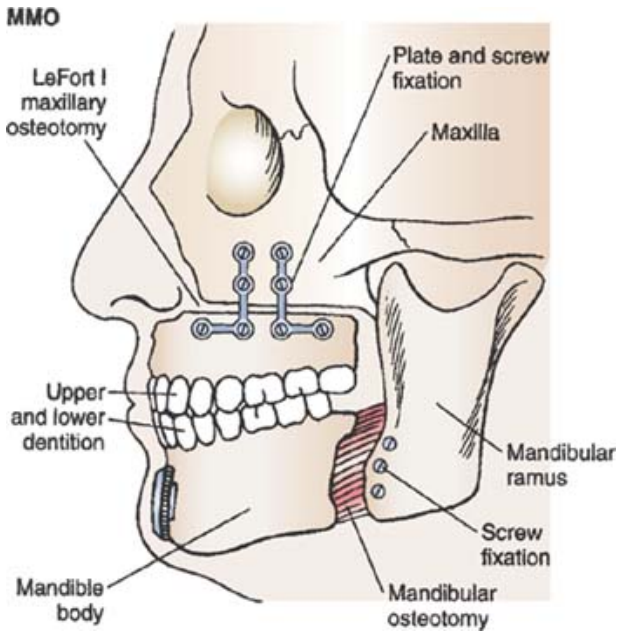

Figure 3-26. Maxillomandibular osteotomy (MMO) and advancement surgery technique.

Tracheotomy is a procedure performed to bypass pharyngeal obstruction. It is usually reserved for those individuals with severe OSA and may be used to secure the airway before other procedures. Preop evaluation, including fiber optic examination, will help identify those individuals whose airways are so compromised that the tracheotomy should be done with the patient awake and under local infiltration anesthetic. A horizontal cervical incision is performed midway between the manubrium and the cricoid cartilage. Dissection is carried out in the midline down to the trachea, frequently transecting the thyroid gland; then, an opening in the superior trachea allows placement of a tracheotomy tube (see p. 186).

Radiofrequency (RF) probes use heat to cause reduction and tightening of tissue. This may be used to enable the airway at the level of the nose (by reduction of the turbinates), the palate, or the base of tongue. Whereas the nasal and palatal procedures are usually performed as outpatient under local anesthesia, the initial treatment of the base of tongue commonly is performed in the OR, either alone or in conjunction with other airway procedures. The area of the tongue just anterior to the circumvallate papillae is infiltrated with local anesthetic. A needle-like RF probe is then used to heat the tissue. There is usually little or no immediate edema, although the surgeon may admit the patient overnight for airway observation.

Usual preop diagnosis: Sleep disordered breathing, including upper airway resistance syndrome and obstructive sleep apnea (OSA) syndrome

Summary of Procedures

Position	Supine
Incision	Intraoral (except HM–horizontal cervical above hyoid bone)
Special instrumentation	For osteotomy cases (MOGA, MMO), sagittal and reciprocating saws, drills
Unique considerations	When using a CO_2 laser (LMG, LP), a laser-safe ETT or, more commonly, a tracheotomy tube is required. MMO requires a nasal intubation. Tracheotomy may be performed with patient sitting with iv sedation and/or local infiltration. Dexamethasone 8 mg iv.
Antibiotics	Cefazolin 1 g iv
Surgical time	UPPP, UPF: 20–60 min UPPGP, LMG, LP: 1–3 h MOGA, HM: 30–60 min MMO: 3–5 h
EBL	UPPP, UPF, MOGA, HM: 0–100 mL UPPGP, LMG, LP: 50–250 mL

	MMO: 100–500 mL
Postop care	UPPP, UPF: PACU → ward Multiple procedures, MMO, labile HTN: ICU → ward
Mortality	Rare
Morbidity	Paresthesias: 10% HTN: 5% Wound dehiscence: 5% Bleeding: 1–2% Infection: 1–2% Hematoma/seroma: 1–2% Upper airway obstruction: 1%
Pain score	UPPP, UPPGP, LMG, LP: 8–10 UPF, MOGA, HM, MMO: 6–8

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Patient Population Characteristics

Age range	Children, adolescents, adults
Male:Female	3–10:1
Incidence	4–10% of adult males; 2–4% of adult females
Etiology	Upper airway collapse by frank obstruction or muscular relaxation
Associated conditions	Systemic and pulmonary HTN; CAD; cardiac arrhythmias; GERD; depression; obesity; polycythemia

Anesthetic Considerations

Michael W. Champeau

Preoperative

Patients with OSA often present with a variety of related medical conditions. These may range from chronic fatigue to conditions that place the patient at an increased risk of sudden death. Some patients have OSA associated with morbid obesity (see p. 502). Typically, patients with OSA are exquisitely sensitive to sedative drugs. Preop evaluation should include their ability to tolerate the supine position without obstructing.

Respiratory	Chronic OSA → hypoxia/hypercarbia → pulmonary HTN → right heart failure. Careful assessment of the airway is essential (suitability for mask ventilation vs. need for awake FOL or tracheostomy). Typically, 25% of patients will present with airway management problems that may require awake FOL (4%) or tracheostomy (3%). Preop evaluation should include a discussion with the surgeon of the results of preop fiber optic nasopharyngoscopy. **Tests:** PFT; ABG and CXR, if indicated from H&P.
Cardiovascular	Patients are at ↑ risk for systemic and pulmonary HTN (Sx: loud P_2 clubbing, ↑ JVD, cyanosis, RVH, right-axis deviation), cardiac arrhythmias, cerebrovascular disease, and CAD. Patients may have dyspnea on exertion and at rest, making routine assessment of cardiovascular function and reserve difficult. **Tests:** ECG; stress ECHO if abnormal ECG; others as indicated from H&P.
	These patients may be chronically fatigued and irritable due to

Neurologic	disrupted sleep patterns. Daytime sleepiness also may be associated with hypothyroidism or anemia, which should be ruled out. **Tests:** As indicated by H&P.
Hematologic	Chronic hypoxia → polycythemia (Sx: clubbing, cyanosis) →↑ risk of CVA. **Test:** Hct
Gastrointestinal	This patient population has a higher incidence of GERD and hiatal hernia; thus, full-stomach precautions (see p. B-4) may be required.
Laboratory	**Tests:** As indicated from H&P.
Premedication	Typically, sedative medications should be kept to a minimum in this patient population. If sedative premedication is given, the anesthesiologist **must** remain with the patient and be prepared to manage the airway.

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Intraoperative

Anesthetic technique: Typically GETA; however, patients undergoing UPF, MOGA, and HM may only require MAC.

Induction	Consideration must be given to securing the airway before induction of anesthesia if a difficult intubation is anticipated. Fiber optic intubation with meticulous topical anesthesia and minimal sedation is recommended for these patients (see Awake FOI, p. B-5); otherwise, standard induction with no muscle relaxant until ability to mask ventilate is assured. An intermediate-acting (e.g., vecuronium 0.1 mg/kg) muscle relaxant may be administered after mask ventilation is established. MMO requires nasal intubation.
Maintenance	Maintenance with N_2O, propofol, and narcotics, in conjunction with low-dose inhalational agents (e.g., sevoflurane 0.4%), will facilitate a rapid and smooth emergence compared to maintenance with higher doses of other inhalational agents. The use of propofol (75–125 mcg/kg/min) and remifentanil (0.05–0.125 mcg/kg/min) infusions in conjunction with N_2O and low-dose sevoflurane has been particularly successful in providing the smooth, rapid emergence required for safe extubation of these patients. Anticipate ↑ BP in response to the surgical procedure, especially in patients with pre-existing HTN, during UPPP, and with down-fracture of pterygoid plate in MMO. Resist temptation to treat ↑ BP with ↑ inhalational anesthetics alone, as the quality of emergence will be compromised. Labetalol (5 mg increments) and hydralazine (5 mg increments) usually are required, whereas esmolol and SNP infusions are needed occasionally. Dexamethasone 0.1–0.15 mg/kg is recommended to ↓ postop airway edema.
Emergence	The patient must remain intubated until sufficiently awake to respond to a series of verbal commands. Premature extubation can cause complete loss of airway (2° glossopalatal obstruction) or laryngospasm. Airway is likely to be worse upon emergence than preop 2° surgically induced edema. Extubation over a tube changer may be appropriate in rare cases. Anticipate pain and ↑ BP during emergence, which will continue into first postop day. Narcotic analgesics (e.g., morphine 0.1–0.15 mg/kg) should be administered before emergence. Antihypertensive agents usually required, as postop HTN can cause bleeding, particularly from osteotomy sites.
Blood and fluid requirements	IV: 16–18 ga × 1 NS/LR @ 1–3 mL/kg/h Minimal-to-little blood loss with all except MMO. EBL with MMO is 100–500 mL. Attempt to minimize fluids to reduce severity of postop airway edema (< 1000 mL of NS/LR for all except MMO; < 2000 mL for MMO).

Monitoring	Standard monitors (p. B-1) Arterial line (MMO)	Arterial line also suggested for postop BP control in all patients with pre-existing HTN and in any patient who displays labile BP intraop. Control of BP in the postop period is an extremely high priority.
Positioning	and pad pressure points. eyes.	Occasional requests for minimal Trendelenburg or semi-sitting positioning.
Complications	ETT damage Hemorrhage Dysrhythmias	ETT may become dislodged or kinked during surgical manipulations. Vagally-mediated severe bradycardia/asystole may occur with maxillary or mandibular advancement during MMO.

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Postoperative

Complications	Airway compromise Airway obstruction	Airway compromise 2° hematoma, edema, excessive sedation, or underlying disease. Consider observation in ICU for patients having multiple procedures, MMO, or labile HTN.
	HTN	Postop HTN is extremely common and can contribute significantly to likelihood of postop airway obstruction 2° hematoma.
	Aspiration	
Pain management	Minimize iv narcotics.	Avoid excessive postop sedation. UPPP patients, in particular, should be warned preop of anticipated significant postop discomfort.

Suggested Readings

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(Print pagebreak 258)
14. Riley R, Powell N, Guilleminault C: Obstructive sleep apnea syndrome: a review of 306 consecutively treated surgical patients. *Otolaryngol Head Neck Surg* 1993; 108:117–25.

15. Riley RW, Powell NP, Guilleminault C, et al: Obstructive sleep apnea surgery: risk management and complications. *Otolaryngol Head Neck Surg* 1997; 117(6):648–52.

16. Sher A, Schechtman K, Piccirillo J: The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. *Sleep* 1996; 19(2):156–77.

17. Woodson BT, Fujita S: Clinical experience with lingualplasty as part of the treatment of severe obstructive sleep apnea. *Otolaryngol Head Neck Surg* 1992; 107:40–8.