

2. Minimally invasive and advanced ambulatory procedures

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Recent advancements in surgical techniques have resulted in shorter, less-invasive procedures, and newer anesthetic agents have facilitated rapid recovery with fewer adverse side effects. These improvements have resulted in a tremendous increase in the scope and extent of surgical procedures performed on an ambulatory basis in the last two decades. In addition, patients are better informed

Box 2-1. Factors that preclude performing advanced ambulatory surgery procedures in freestanding centers

Patient-related	Significant cardio-respiratory comorbidities: American Society of Anesthesiologists physical status III
Procedure-related	Specialized equipment Potential for major complications
Surgeon-related	Potential for extended duration of surgery

and are beginning to play an active role in their health care decisions and are demanding the type of highly efficient, streamlined care commonly associated with ambulatory facilities. Initially, only the less complex procedures were performed as ambulatory surgery, but the excellent safety record of ambulatory anesthesia has prompted surgeons to widen the range of procedures being conducted in ambulatory facilities (Box 2-1). This chapter will highlight surgical procedures not traditionally considered as ambulatory surgery and familiarize anesthesiologists with both the surgical and anesthesia considerations that will help promote and work toward safe clinical management for same-day discharge.

General surgery procedures

Biliary tract surgery

Laparoscopic cholecystectomy

The evolution of ambulatory laparoscopic cholecystectomy surgery is a good example of the process by which inpatient procedures come to be advanced and then routine ambulatory procedures. Initially, small select groups of patients were discharged home after the procedure, which has now come to be regarded as the “gold standard” for the treatment of cholelithiasis.^{1,2} A prospective study of patients who had laparoscopic cholecystectomy in a simulated home setting in a hospital reported that all patients met discharge criteria within 6 hours of surgery. Ninety-four percent of patients required only oral analgesics; however, 12% of patients experienced postoperative nausea and vomiting requiring parenteral therapy and 3% required an additional day in the hospital.³

Considerations for ambulatory laparoscopic surgery

Preoperatively, patients must be evaluated to confirm that they are able to tolerate the cardiorespiratory effects of laparoscopy (Box 2-2). Patients must be kept warm with a heated forced-air blanket, and intravenous fluids should be warmed if needed to address hypothermia from insufflation of cold, dry gas. Local anesthetic infiltration of the laparoscopy portals will reduce somatic pain, and subdiaphragmatic injection may reduce the referred shoulder pain.

Box 2-2. Physiologic effects of laparoscopy

Effects of position	Trendelenberg: ↓ FRC, ↓ total lung capacity, ↓ compliance reverse Trendelenberg: ↓ preload, ↓ cardiac output
Ventilatory effects	Decreased FRC, FEV1, VC, compliance Increased airway pressure, alveolar-arterial O ₂ gradient
Hemodynamic effects	Aortic compression: ↑ SVR, ↓ cardiac output Vena cava compression: ↓ preload, ↓ cardiac output
Vascular effects	Decreased hepatic, renal, mesenteric blood flow
Neurohumoral effects	Increased vasopressin, Renin, aldosterone, epinephrine, norepinephrine

FEV1, forced expiratory volume in 1 second; FRC, functional residual capacity; SVR, systemic vascular resistance; VC, vital capacity.

Nonsteroidal anti-inflammatory agents are routinely used as adjuncts to reduce opioid requirements. Pre-emptive multimodal antiemetic therapy will reduce the potentially high incidence of postoperative nausea and vomiting. Hemorrhage, pneumothorax, gas embolism, extra-abdominal emphysema, vascular, or visceral injury are rare complications.

Gastric surgery

Laparoscopic gastric banding

Gastric portioning procedures are devised to promote weight loss by decreasing the size of the gastric pouch and thereby limiting the amount of food ingested at one time. These patients frequently have a body mass index well in excess of 35–40 kg/m², and specially sized gurneys, wheelchairs, operating tables, instrumentation, and moving devices are required to facilitate the proper care of these patients. Gastric banding has been performed in a freestanding ambulatory surgery center.⁴ Patients need preoperative evaluation for cardiorespiratory and airway abnormalities associated with morbid obesity. Screening for obstructive sleep apnea is essential and these patients may not be suitable for ambulatory discharge (Figure 2-1).

Diabetes mellitus is common in obese patients, and perioperative control of blood sugar is essential. Liver function must be evaluated since it is often abnormal and results in altered drug metabolism.

An appropriately sized blood pressure cuff may provide accurate measurements, but more often optimum application is hindered by the shape of the patient's arms. A comparison of blood pressure measurement in obese patients by means of a standard-sized cuff on the forearm and upper arm revealed that the forearm blood pressure values are overestimated, but correlate, when compared to the upper arm.⁵

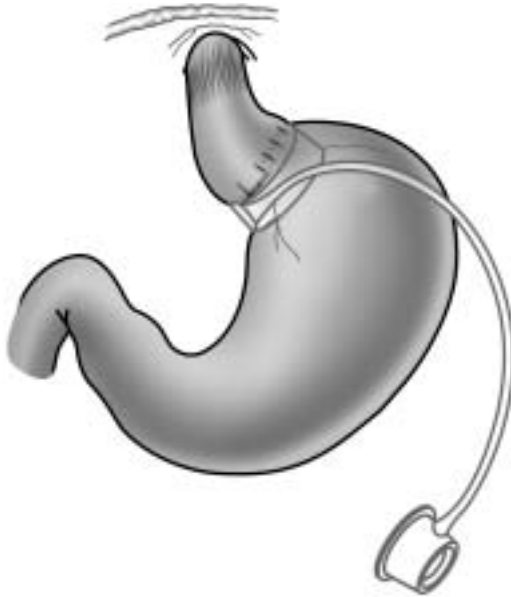


Figure 2-1. Adjustable gastric banding.

Aspiration prophylaxis is indicated and may include intravenous premedication with H_2 antagonists (ranitidine 50 mg), metoclopramide (10 mg), and sodium citrate 30 mL orally. Positioning of morbidly obese patients is essential to facilitate endotracheal intubation and ventilation. This includes elevation of the shoulders and occiput so that the head is in the “sniffing” position, and the use of a 30° reverse-Trendelenburg position will facilitate respiratory mechanics.⁶ Thorough preoxygenation with attention to the expired oxygen concentration, which should be at least in the low- to mid-90% range, will prevent rapid desaturation during intubation.⁷ If fiber-optic intubation is necessary, it is advisable to administer intravenous anticholinergic agents preoperatively to prevent interference with visualization due to excessive secretions. Because endotracheal tube displacement into the mainstem bronchus as a result of upward movement of the diaphragm and carina has been reported, endotracheal tube placement should be verified following insufflation of the abdomen with carbon dioxide and Trendelenburg position.⁸

Pharmacokinetics is altered in obese patients, and care must be exercised in dosing anesthetic agents (Box 2-3). Dosage based on corrected body weight (CBW) has been proposed⁹ using the following calculation: $CBW = \text{ideal body weight} + [0.4 \times \text{excess body weight}]$.

Remifentanyl has been shown to facilitate early recovery in obese patients undergoing laparoscopy¹⁰ and also would be suitable for gastric banding procedures, in which postoperative pain is minimal and small doses of morphine or hydromorphone can be used following the discontinuation of the remifentanyl infusion. Recovery after desflurane has also been shown to be more rapid

Box 2-3. Pharmacokinetic/pharmacodynamic alterations in obesity

Midazolam	$\uparrow V_D$, \uparrow clearance	Dose by ABW
Propofol	$\downarrow V_D$, \downarrow clearance	Dose by ABW
Fentanyl, sufentanil	$\uparrow V_D$, \uparrow clearance	Dose by ABW
Remifentanyl	\uparrow Clearance, $\downarrow V_D$	Dose by IBW
Succinylcholine	\uparrow Plasma cholinesterase	Dose by ABW
Rocuronium	$\downarrow V_D$, \downarrow clearance	Dose by IBW
Cisatracurium, atracurium	Clearance, V_D unchanged	Dose by ABW

ABW, actual body weight; IBW, ideal body weight; V_D , volume of distribution. Adapted from Casati et al.⁵⁶ © Elsevier. Used with permission.

compared to propofol or isoflurane.¹¹ Postoperative complications requiring hospital admission in a group of 343 ambulatory patients included nausea (1), bloody nasogastric drainage (1), and esophageal spasm (1).

Esophageal surgery

Laparoscopic fundoplication

Laparoscopic antireflux surgery is performed to relieve symptoms of gastro-esophageal reflux in patients who want to discontinue long-term medications or who get only partial relief or experience adverse side effects from the medication. The Nissen fundoplication has a greater than 80% success rate. It has been reported that the procedure has been performed on an ambulatory basis with 98% of patients being discharged 4 hours after surgery.¹² (Figure 2-2).



Figure 2-2. Nissen fundoplication.

Preoperatively, patients should be carefully evaluated for evidence of recurrent aspiration pneumonia. There is a risk of regurgitation and aspiration with induction of anesthesia. Intravenous premedication with H_2 antagonists (ranitidine 50 mg), metoclopramide (10 mg), and sodium citrate 30 mL orally should be considered.

The surgery is performed with general anesthesia. Due to the risk of aspiration on induction, either awake fiber-optic intubation or rapid sequence induction is employed. Postoperatively, in addition to standard discharge criteria, patients are required to demonstrate the ability to swallow sips of water without vomiting, and on the first postoperative day, patients undergo a gastrografin swallow test to demonstrate absence of leakage.

Laparoscopic splenectomy

Splenectomy is indicated in the management of a variety of hematological diseases such as purpura, lymphoma, leukemia, sarcoidosis, or myelofibrosis. The surgery is performed laparoscopically if the spleen is of normal size or only moderately enlarged. Recently, it has been reported to have been performed successfully in a small group of ambulatory patients.¹³ Patients are positioned in the left lateral decubitus position, and pressure points should be carefully padded and protected. In addition to routine complications of laparoscopy, blood loss is typically in the range of 750 to 1,000 mL, and adequate intravenous access is essential for prompt replacement.

Breast surgery

Mammoplasty

Reduction mammoplasty is performed to reduce the breast size by removal of breast tissue, usually in the range of 200 to 1,000 grams. Many of these patients are morbidly obese and should be carefully screened preoperatively for comorbidities, especially the presence of obstructive sleep apnea. Augmentation mammoplasty consists of the insertion of prosthesis above or below the pectoral muscle and may be performed for cosmetic reasons in normal patients or in patients who have undergone surgery for breast cancer. In the patient with cancer, it is important to determine the type of chemotherapeutic agents that these patients might have received. The alkylating agents are associated with pulmonary toxicity, adriamycin causes cardiomyopathy, and methotrexate may produce renal and hepatic dysfunction. Establishing intravenous access in these patients may be quite challenging since many of these agents cause thrombophlebitis and the new veins that develop are small and tortuous. Inhalation induction may be a desirable alternative in these cases.

Both general and local anesthesia have been used for these procedures. Patients are usually in the sitting position during surgery and for the application of the dressings at the end of surgery. Postoperatively, submuscular breast augmentation results in significantly more postoperative pain than subglandular

insertion of the prosthesis. The pain is thought to be related to pectoralis muscle spasm, may last up to a week after surgery, and limits movement of the arm. Patients may require opioid analgesics following surgery; however, the use of continuous paravertebral catheters for infusion of local anesthetics has been shown to be an effective alternative. Patients have less postoperative pain, require less analgesics and antiemetics, have less restriction of arm movement, and can be discharged home within a few hours of the completion of surgery.¹⁴ The complication rate following paravertebral blocks is low (in the range of 2.6% to 5%).¹⁵ There is a potential risk of epidural spread of local anesthetic, local anesthetic toxicity, and pneumothorax. These complications, though rare, must be kept in mind in the ambulatory surgery patient who may not develop the signs and symptoms until after discharge. Therefore, this type of analgesia requires careful patient selection, preoperative education, a dedicated home caregiver, detailed written discharge instructions, ready access to the health care facility, and the ability of the patient to communicate effectively with the physician at all times.

Mastectomy

The transition to more breast-conserving procedures with less postoperative morbidity has resulted in a steady increase in ambulatory surgery for breast cancer. Procedures performed as ambulatory surgery include complete mastectomy (8%–22%), subtotal mastectomy (43%–72%), and lumpectomy (78%–88%).¹⁶ A review of mastectomies performed in Florida in 1994 revealed that of a total of 5,418 surgeries, 1,089 had been ambulatory surgeries and the readmission rate was only 1.3%.¹⁷ The variables that were associated with an increased odds of having mastectomy on an ambulatory basis were age (1% for each year), low incidence of comorbidities, higher level of income, nonurban (outside urban area or in rural area) residence, lack of insurance coverage, and the type of surgery. It has also been reported that patients who underwent ambulatory mastectomy manifested better emotional adjustment and fewer psychological distress symptoms than those who had been inpatients following surgery.¹⁸

Patients with breast cancer who have received preoperative radiation and/or chemotherapy need to be assessed preoperatively for the cardiopulmonary side effects of these treatments. Breast cancer often metastasizes to the brain, and alteration in mental status should be carefully evaluated.

Surgery may be performed with a combination of local anesthesia and intravenous sedation/analgesia, paravertebral somatic blocks, or general anesthesia. Pressure dressings are applied at the end of the procedure, and the patient may be required to sit up for the application. Due to interruption of nerves to the chest wall, postoperative pain following mastectomy may be less than expected. Axillary surgery may be more painful due to proximity to the shoulder joint and the presence of a drainage tube that moves with arm motion. Continuous paravertebral blocks with an indwelling catheter and infusion of local anesthetic (0.2% ropivacaine) offer an alternative to inpatient admission for the sole purpose of analgesic therapy.¹⁹

Endocrine surgery

Thyroidectomy

Thyroidectomy may be performed for benign conditions such as goiter, hyperthyroidism and benign nodules, or malignancy. Though not a common practice, ambulatory thyroidectomy was reported several years ago. Patients were discharged on the day of surgery following evaluation by the surgeon, with telephone follow-up on the evening of surgery and an office visit the next day.²⁰ More recently, there has been a renewed interest in performing these procedures on an ambulatory basis.²¹

Thyroid function tests need to be reviewed preoperatively for evidence of hyper- or hypothyroidism. Since myxedema coma is associated with a greater than 50% mortality rate, severely hypothyroid patients require thyroid replacement prior to surgery. Intraoperatively, thyroid storm can be mistaken for malignant hyperthermia (Box 2-4). A computed tomography (CT) scan of the neck is necessary to evaluate the airway since large goiters may give rise to tracheal compression or deviation. Vocal cord function must be evaluated prior to discharge since postoperative airway obstruction may occur due to damage to the recurrent laryngeal nerve, hematoma formation, or tracheomalacia. For this reason, this procedure is probably not suitable for freestanding facilities.

Adrenalectomy

Adrenalectomy is performed for tumors or benign hyperplasia. The extension of laparoscopic surgery to adrenalectomy has allowed the procedure to be performed on an ambulatory basis.²² Whereas patients with pheochromocytomas are not suitable for ambulatory surgery, those with Cushing syndrome (hyperadrenocorticism) and Conn syndrome (hyperaldosteronism) may be but will need careful evaluation of their cardiac and renal function prior to surgery. Serum electrolyte levels need to be verified to rule out hyponatremia and hypokalemia which will require correction. Surgery is performed with general anesthesia, and a multimodal approach to pain and nausea and vomiting prophylaxis facilitates timely discharge.

Box 2-4. Intraoperative signs and symptoms

Thyroid storm	Malignant hyperthermia
Tachycardia	Tachycardia
Arrhythmias	↑ CO ₂ , ↓ SaO ₂
↑ Temperature	↑ Temperature
Sweating	Metabolic acidosis

SaO₂, oxygen saturation.

Neurosurgical procedures

Intracranial neurosurgery

Stereotactic techniques allow the neurosurgeon to precisely localize brain lesions and perform “awake” craniotomies with sedation/analgesia on an outpatient basis.^{23,24} These procedures may require the fixation of a frame to the head or radiologically visible markers called fiducials to be fixed to the scalp and forehead with adhesive. Once the frame or markers are attached, a magnetic resonance imaging (MRI) or CT scan is obtained to determine stereotactic coordinates, after which the frame or fiducial markers must not be moved until the procedure is completed. The “key” for removal of the frame must be readily available at all times in the event of an airway emergency (Figure 2-3).

This technique allows biopsy of deep lesions,²⁵ functional surgery for movement disorders²⁶, and noninvasive radiation for brain lesions.²⁷ If the procedure is to be performed with general anesthesia, fiber-optic intubation may be necessary to avoid manipulation of the frame. However, the procedures are usually

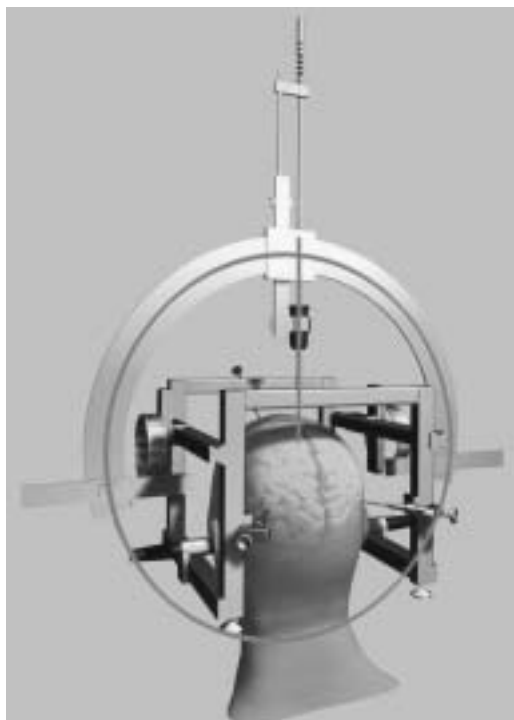


Figure 2-3. Stereotactic frame in position.

performed with local infiltration and sedation/analgesia since the patient must be conversant at all times. Small doses of midazolam and a continuous infusion of propofol together with fentanyl or remifentanyl may be used for sedation. During deep brain stimulation, propofol and dopaminergic agonists and antagonists (metoclopramide and droperidol) should be avoided.

Postoperative pain is usually minimal, but nausea and vomiting may be significant, and prophylactic antiemetics should always be administered. Patients are observed until they are able to ambulate and tolerate oral intake and are evaluated by the neurosurgeon prior to discharge. In most cases, patients receive a follow-up visit by a home care nurse later the same day. Postoperative bleeding is the most common complication and usually presents within the first 6 hours or more than 24 hours postoperatively. Patients are discharged with explicit instructions to contact the surgeon and return to the emergency room if specific signs or symptoms develop. For this reason, adequate support at home and access to the hospital for readmission are important selection criteria for performing these surgeries on an ambulatory basis. These procedures are usually performed in hospital-based centers due to the specialized equipment needs and potential complications.

Spinal neurosurgery

Microdiscectomy and percutaneous discectomy are minimally invasive procedures for decompression of the lumbar nerve roots and are performed to relieve radicular irritation due to herniated lumbar discs. Several studies have demonstrated the feasibility of performing these procedures on an outpatient basis.^{28,29} A small incision is made over the proposed interspace, the soft tissue is displaced to expose the ligamentum flavum which is removed, the nerve root is retracted, and the disc material is removed.

Preoperatively, neurologic findings should be carefully documented. Patients are frequently on nonsteroidal anti-inflammatory agents or aspirin, and hematologic status may need to be evaluated. Microdiscectomy may be performed under local anesthesia with sedation or regional or general anesthesia. Percutaneous discectomies are usually performed only with sedation/analgesia to allow the patient to inform the surgeon of inadvertent nerve root contact, which is usually extremely painful. Sedation/analgesia with a small dose of midazolam and low-dose propofol infusion, supplemented with an opioid, will result in a comfortable but arousable patient.

Subarachnoid block with tetracaine (10–14 mg) or bupivacaine (8–12 mg) may also be used for this surgery. A group of patients who underwent microdiscectomy with subarachnoid block (isobaric 0.5% bupivacaine) combined with wound infiltration had lower pain scores and analgesic requirements compared to those who had received general anesthesia.³⁰

Postoperatively, there is a high incidence of moderate to severe pain (34%), vomiting is in the range of 9.5%, and the unanticipated admission rate is approximately 5.7%.³¹ Patients are discharged once standard discharge criteria are met and postoperative examination by the neurosurgeon has been performed. Major vascular injury is a rare complication (1.6 per 10,000) that, if not recognized

intraoperatively, will be identified in the postanesthesia care unit. Urinary retention may occur postoperatively, and for this reason all patients are required to void prior to discharge. The role of the surgical procedure in the etiology of this complication is unclear. However, the factors predictive of early postoperative failure to void have been found to be age of more than or equal to 50 years, intraoperative fluid administration of more than or equal to 750 mL, and bladder volume of more than or equal to 270 mL on admission to the postanesthesia care unit.³²

Ophthalmic procedures

Vitreoretinal surgery

Although the great majority of ophthalmic surgeries are performed on an ambulatory basis, vitreoretinal surgeries have traditionally been considered inpatient procedures. However, there is a recent trend toward ambulatory vitreoretinal surgery. There is a suggestion that outcomes may be improved in ambulatory patients due to greater vigilance in maintenance of special positioning postoperatively by supportive family members as compared to busy hospital nurses.³³ Vitreoretinal surgery is performed for repair of retinal detachment, vitreous hemorrhage, macular epiretinal membrane peeling, posterior segment foreign bodies, and trauma. The surgery may involve scleral buckling, vitrectomy, gas-fluid exchange, and injection of vitreous substitutes. The scleral buckle is an extraocular surgery and consists of suturing a silicone rubber appliance to the sclera to indent the eye and functionally close the retinal tear. Vitrectomy is an intraocular procedure and consists of partial or complete removal of the vitreous and introduction of saline, perfluorocarbon gas, or silicone oil in exchange.

Preoperatively, a thorough evaluation of the cardiac and renal status is essential since patients may have received acetazolamide or mannitol preoperatively to decrease intraocular pressure (IOP). Rapid infusion of mannitol may precipitate congestive heart failure and electrolyte abnormalities and possibly myocardial ischemia. Acetazolamide also inhibits renal carbonic anhydrase, and patients receiving it may be acidotic, hypokalemic, and hyponatremic. Many patients undergoing retinal surgery are diabetic and are at increased risk for aspiration if they have gastroparesis. These patients will also require close monitoring of their blood sugar in order to maintain it within the normal range perioperatively.

Retinal surgery may be performed under regional or general anesthesia. Nitrous oxide is usually avoided since the ophthalmologist may inject hexafluoride (SF₆) or perfluoropropane (C₃F₈) into the posterior chamber and diffusion of nitrous oxide into the gas bubble may cause a dramatic increase in IOP which may compromise retinal blood flow. The gas is absorbed very slowly, and if the patient undergoes subsequent general anesthesia, nitrous oxide should be avoided for several days following air injection (Box 2-5).

Postoperatively, the most common reason cited for admission has been pain and nausea. These symptoms are more severe in the presence of increased IOP (>40 mm Hg) or with scleral buckling³⁴ and may be minimized by the preemptive administration of antiemetics and the use of regional anesthetic blocks.

Box 2-5. Intravitreal gas absorption

Air	5 days
SF ₆	10 days
C ₃ F ₈	15–30 days

Thoracic procedures

Mediastinoscopy

Mediastinoscopy is performed to diagnose mediastinal masses and to sample lymph nodes in order to stage pulmonary tumors. The procedure involves the introduction of a short endoscope into the anterior mediastinum through a small incision in the suprasternal notch. The proximity of major vascular structures is associated with the potential for massive hemorrhage, and the presence of superior vena cava (SVC) obstruction may give rise to markedly distorted anatomy. Nonetheless, in one large series of 1,015 ambulatory mediastinoscopies, only 10 patients experienced postoperative complications that required hospitalization.³⁵ These included supraventricular arrhythmias and postoperative myocardial ischemia and were related to pre-existing comorbidities rather than the surgery.

The anesthetic management of patients undergoing this procedure presents several challenges. Preoperatively, patients must be evaluated for significant SVC obstruction by checking the blood pressure in both upper extremities, and the equipment for invasive blood monitoring should be available. If SVC obstruction is present, the blood pressure in the right arm will be significantly lower than in the left. Airway compression may present and is manifested by an inability to lay supine or by wheezing or stridor. A preoperative CT scan or MRI will be necessary to confirm these conditions. These patients may not be suitable for ambulatory discharge.

In the case of a large mass, a large bore intravenous catheter should be inserted in the lower extremity. Patients with lung cancer may have myasthenic syndrome, and neuromuscular blockade should be carefully monitored. Postoperative pain is well controlled with oral analgesics. Hoarseness has been reported following this procedure, and laryngeal nerve damage may require reintubation.³⁶ Less common (0.01%–0.6%) but serious vascular injuries include damage to the pulmonary artery, SVC, azygos vein, aortic arch, and its branches and require immediate thoracotomy. Tracheal and bronchial injury also require operative repair.³⁷

Thoracoscopy

Developments in video-assisted thoracoscopic surgery have revolutionized thoracic surgery. The procedure is used to diagnose and treat pleural or parenchymal lung disease, mediastinal masses, and pericardial disease. Thoracoscopy has been used for treatment of pneumothorax due to apical blebs, Heller

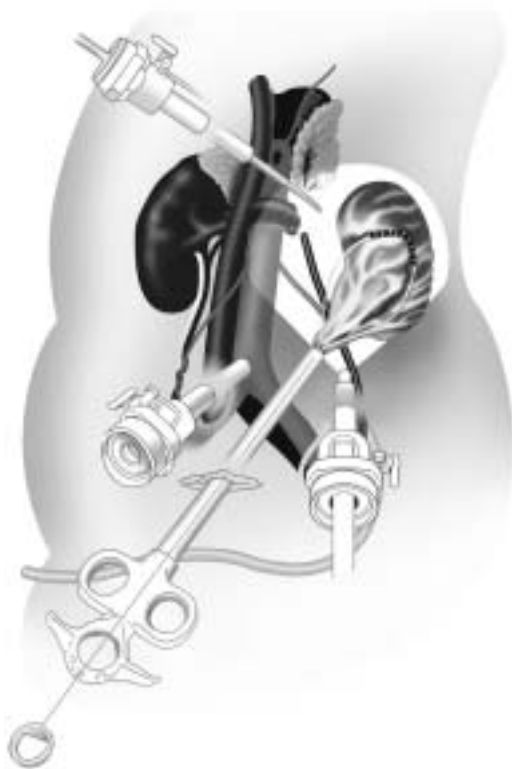


Figure 2-4. Laparoscopic nephrectomy.

myotomy, and upper dorsal sympathectomy. The procedure is associated with fewer cardiopulmonary sequelae than thoracotomy but does require intraoperative one-lung ventilation (Figure 2-4).

A report of patients who underwent the surgery as outpatients indicates that 72.5% were discharged home on the day of surgery and 22.5% the next day (within 23 hours of surgery).³⁸ Reasons for admission included conversion to open thoracotomy and surgery performed late in the day.

Preoperative pulmonary function tests are an integral part of patient evaluation and predict postoperative pulmonary dysfunction. A forced vital capacity of less than 50%, a forced expiratory volume in one second of less than 50%, a maximal breathing capacity of less than 50%, or a residual volume to total lung capacity ratio greater than 50% are all associated with a high risk of significant postoperative morbidity and mortality.

Regional anesthesia may be used for this procedure and consists of a combination of intercostal nerve blocks, stellate ganglion block, and paravertebral block. Most frequently, however, general anesthesia is used with double-lumen

tubes or bronchial blockers to facilitate lung isolation and visualization of the thoracic cavity.

Following closure of the port sites and placement of the chest tube, the collapsed lung is gently reinflated with gradually increasing tidal volumes. The chest tube can be safely removed within 90 minutes of surgery and results in a marked reduction in postoperative pain and analgesic requirements. In most healthy patients, postoperative pain is controlled with nonsteroidal anti-inflammatory drugs and opioid analgesics. Epidural analgesia is used in those patients who have significant cardiac or pulmonary disease. Postoperative complications include hemorrhage, airway obstruction, and air embolism.

Limited thoracotomy

Outpatient open-lung biopsy in non-oxygen-dependent patients has been reported.³⁹ Lung biopsies are often required to make a definitive diagnosis in patients with interstitial lung diseases. The surgeries are performed with general anesthesia. All patients had a chest radiograph prior to transfer to the day surgery unit and were discharged home several hours later with oral analgesics. Avoidance of rib retractors and a chest tube will minimize postoperative pain and facilitate discharge. The authors stress that patient selection and technical aspects of the surgery are critical to the successful outcome of the surgery. In view of the potential complications and special monitoring needs, mediastinoscopies, thorascopies, and limited thoracotomies are not suitable for freestanding ambulatory centers.

Cardiovascular procedures

Cardiac surgery

Video-assisted thoracoscopy has been used to facilitate the interruption of a patent ductus arteriosus.⁴⁰ Patients ranged in age from several days to 50 years of age. In the non-neonate group, 18 patients were discharged on the day of surgery, whereas 6 were observed overnight in the day surgery unit and one was admitted because of small size and a history of premature birth. The 50-year-old patient was admitted because of the presence of subcutaneous emphysema related to a bronchial injury following double-lumen endobronchial tube placement.

A recent report of coronary artery bypass grafting in awake patients described 12 patients who underwent median sternotomy and revascularization with thoracic epidural anesthesia.⁴¹ The average procedural time was 98.2 ± 19.8 minutes, and intermediate care stay was 4.9 ± 0.6 hours. Although all patients recovered well, they remained hospitalized for 7.8 ± 0.5 days due to reimbursement regulations. The authors concluded that with further refinement of the procedure,

outpatient coronary artery bypass surgery may be feasible! The growth in percutaneous coronary intervention has eclipsed the number of interventions performed by a surgical approach overall, because of the less invasive nature of the revascularization procedure with less procedural mortality and morbidity. These procedures are performed with local anesthesia and mild sedation, and the patients are discharged home after a day's observation and return to work in a week. The introduction of drug-eluting stents has addressed the problem with restenosis, and it is speculated that the role of surgical coronary revascularization will continue to decrease as a proportionate share of total revascularization procedures.

Vascular surgery

Carotid endarterectomy

Carotid endarterectomy is one of the most common vascular surgeries and is now being added to the list of ambulatory surgeries, with patients being discharged following an 8-hour observation period.⁴² Thirty-two percent of patients were discharged on the day of surgery and did not experience any adverse sequelae. The surgeons commented that another 34% of patients could have been discharged if their surgery had been scheduled for earlier in the day.

There are two types of patients who undergo carotid surgery: those who have suffered a series of transient ischemic attacks and those who have had strokes. The carotid artery is approached through an incision in the neck, and following administration of heparin, the internal, external, and common carotid arteries are clamped, the vessel is opened to remove the thrombus, and arteriotomy is closed. Heparin effect may be reversed with protamine. In some cases, an indwelling shunt may be used to maintain carotid blood flow during the period of arterial occlusion.

Preoperatively, a careful cardiovascular examination must be conducted. Blood pressure must be measured in both arms, and if there is a difference, it should be measured in the arm with the higher values during and after surgery. A preoperative electrocardiogram is mandatory since at least 1% of patients will have a myocardial infarction postoperatively. It is important to evaluate the effect of hyperextension and lateral rotation of the neck on neurologic symptoms since occlusion of compromised vertebral-basilar flow due to head positioning may result in perioperative cerebral ischemia. Platelet function may be altered in patients who have been on chronic aspirin therapy. Preoperative sedatives should be avoided since they may make it difficult to evaluate neurologic status in the immediate postoperative period.

The combination of superficial and deep cervical plexus block has been used for this surgery. There is some evidence that local anesthesia is associated with a lower incidence of shunting and less hemodynamic instability.⁴³ The patient's mental status serves as a monitor of the cerebral function during the period of arterial occlusion in these cases. Local anesthetic blockade of the phrenic nerve occurs in all patients undergoing cervical plexus block, and brachial plexus blockade is not an infrequent occurrence.

When general anesthesia is employed, short-acting agents are preferred to allow for evaluation of the neurological status of the patient immediately following surgery. General anesthetics have a cerebral protective effect by decreasing the cerebral metabolic rate and redistributing blood flow to ischemic areas. General anesthesia also blunts the stress response to crossclamping the carotid artery.

Cerebral perfusion monitoring plays an important role when carotid endarterectomy surgery is performed under general anesthesia. Electroencephalography (EEG) is considered to be the standard for monitoring patients undergoing carotid endarterectomy. However, EEG may fail to identify small areas of focal ischemia. Transcranial Doppler is a noninvasive method of monitoring the blood flow in middle cerebral artery and detecting microemboli. Measurement of stump pressure is used to clinically evaluate the adequacy of cerebral perfusion. Cerebral ischemia rarely occurs when the stump pressure is greater than 60 mmHg. Many of the procedures performed on an ambulatory basis were performed with regional anesthesia, with the patient's mental status serving as a monitor of the cerebral function.

Circulatory instability is common postoperatively and frequently requires pharmacologic therapy. This is related to the loss of normal carotid baroreceptor function which results in hypertension. Loss of chemoreceptor activity also occurs and results in the loss of the normal ventilatory response to hypoxia. Evidence of new neurological findings postoperatively will require emergent cerebral angiography and re-exploration if an intimal flap is suspected.

Gynecologic procedures

Hysterectomy

Hysterectomy is the second most common surgery performed in the United States; approximately 633,000 are performed each year. Vaginal hysterectomy has been associated with fewer complications and shorter hospital stays than abdominal hysterectomy, whereas laparoscopic hysterectomy (which is less painful) has shortened hospitalization further^{44,45} and has actually been performed on an ambulatory basis.^{46,47} The usual ambulatory procedure is a laparoscopic-assisted vaginal hysterectomy, in which the uterine attachments are freed up laparoscopically and the procedure is completed vaginally. Other variants include total laparoscopic hysterectomy in which the entire surgery is performed through the laparoscope with morcellation and a subtotal laparoscopic hysterectomy which is a supracervical hysterectomy. Many patients have a significant history of uterine bleeding and may be anemic. The procedure is performed with general anesthesia, with patients in the dorsal lithotomy position and often in steep Trendelenberg to displace the abdominal structures.

Complications include acute hemorrhage, perforation of a viscus, and extra-abdominal insufflation such as subcutaneous emphysema, pneumothorax, pneumopericardium, or gas emboli. Carbon dioxide is quickly absorbed, and there is usually no major physiologic compromise.

Urologic procedures

Nephrectomy

Nephrectomies may be performed for benign or malignant conditions and consist of removal of the kidney and a small portion of the ureter or more extensive procedures as in the case of the radical surgery with pelvic lymph node dissection. Advances in laparoscopic surgery have extended to urologic procedures, and urinary diversions, nephrectomy, and nephroureterectomy are performed with this technique. In a series of 51 children who underwent a variety of urologic procedures, 86% of the children were discharged home 7 hours after surgery.⁴⁸ The children all received a caudal block (0.25% bupivacaine with 1:200,000 epinephrine), local infiltration of the wound (0.25% bupivacaine), and ketorolac prior to the end of surgery. Another group of 26 children between the ages of 4 months and 11 years underwent laparoscopic nephrectomy with general anesthesia.⁴⁹ The mean surgery time was 165 minutes and postoperative analgesic requirements were minimal: six patients received no postoperative morphine but instead were given 0.9 mg/kg of codeine. Three of the children were discharged home 6 hours following their surgery.

Laparoscopic nephrectomies are performed with the patient in the lateral decubitus position, and all pressure points must be protected. In addition, small children must be secured to prevent movement with tilting of the operating table. Considerations for children undergoing laparoscopy are similar to those in adults and have already been described.

Prostatectomy

Transurethral resection of the prostate

Transurethral resection of the prostate (TURP) is performed for benign disease unless the gland is very large. The transurethral resection has been successfully performed as an ambulatory procedure in a freestanding facility.⁵⁰ A total of 58 patients had surgery performed with spinal (39 subjects) and general (19 subjects) anesthesia. There were two readmissions, one for tachycardia and one for a fever.

Patients undergoing this surgery are generally elderly with pre-existing medical problems and need careful evaluation and medical optimization preoperatively. Renal function may be impaired due to chronic obstruction, and mental function should be assessed preoperatively in order to allow accurate interpretation of possible perioperative changes due to hyponatremia. Surgery is performed in the lithotomy position, and patients should be positioned carefully and pressure points padded. Regional anesthesia is often preferred because it allows early detection of TURP syndrome by evaluation of mental changes. Considerable bleeding may occur during resection, and large-bore intravenous catheters are necessary for replacement of blood and fluids. Postoperatively, in patients who have had spinal anesthesia, the Foley catheter should be removed only after return of perianal sensation, motor control, and proprioception. Photo-selective vaporization of the prostate (PVP) offers a less invasive approach to

removing enlarged benign prostate tissue. It combines the effectiveness of TURP, the surgical “gold standard” with the safety, comfort, and ease of a therapeutic alternative. The GreenLight laser system uses a very high-powered “green laser” that absorbs hemoglobin which immediately vaporizes and precisely removes enlarged prostate tissue, reducing any bleeding or the need for large-volume irrigation solutions. Most patients return home a few short hours after the PVP procedure and can return to normal, nonstrenuous activities within days. General anesthesia is used for the procedure because of the discomfort the patient experiences during the laser procedure.

Radical prostatectomy

Prostate cancer is the most commonly diagnosed cancer type in men, affecting about one eighth of the male population of the United States. Radical prostatectomy may be performed by a retropubic or perineal approach. As a result of advances in technology, the procedure may be performed on an ambulatory basis in patients with localized tumors.⁵¹ In a series of 40 patients who underwent retropubic prostatectomy, 80% were discharged on the day of surgery. Patients received extensive preoperative education, and all patients were visited at home by a nurse on the night of surgery. Postoperative pain control is the main reason for hospitalization following prostatectomy, and the authors described a “pelvic block” at the bladder neck and base and along the muscle and fascia, which resulted in sufficient analgesia that no additional postoperative analgesia was required and patients were discharged with oral analgesics.

Radical perineal prostatectomy is less painful and has been performed as an ambulatory procedure with concurrent laparoscopic pelvic lymph node dissection.⁵² Ninety-one patients who underwent this surgery were discharged home within 23 hours of the procedure. As with the previous group, these patients received extensive preoperative education and care was standardized by institution of a clinical pathway. All patients were contacted the next day by telephone for follow-up.

General or regional anesthesia may be used, but general anesthesia is preferred if laparoscopic lymph node dissection is planned. Blood transfusion may be necessary with larger prostate glands (more than 30 g). Postoperative peroneal nerve injury has been documented due to high lithotomy position, and patients should be evaluated for this complication after surgery.

Orthopedic procedures

The growth in ambulatory orthopedic surgery has gone hand in hand with the advances in regional analgesic techniques.

Shoulder arthroplasty

Shoulder joint replacement with special implants is performed for severe arthritis or following trauma. Patients presenting for this surgery who have

rheumatoid arthritis must be screened for other joint involvement, including occult subluxation of the cervical spines and cricoarytenoid joint involvement, which may manifest as hoarseness. Bony deformities may make positioning difficult and also complicate endotracheal intubation. Surgery is performed in the sitting position, and accurate blood pressure monitoring is crucial. General and regional anesthesia have both been used for the procedure. The surgery has traditionally required hospital admission for postoperative pain control, but continuous perineural infusion with portable infusion pumps has resulted in the procedure being added to the long list of orthopedic surgeries that are performed on an ambulatory basis.⁵³

Hip arthroplasty

Hip arthroplasty is a proven treatment for advanced arthritis. Improvements in prostheses and surgical techniques have resulted in shorter hospitalizations and more rapid rehabilitation. Minimally invasive arthroplasty has resulted in decreased blood loss and postoperative pain so that patients have been able to leave the facility within 12 hours of surgery⁵⁴ (Figure 2-5). Patients are generally elderly and must be screened preoperatively for comorbidities. Evaluation of cardiac status may be difficult because pain associated with arthritis often limits activity, and pharmacologic stress testing may be necessary in patients suspected of having significant coronary artery disease. Surgery is performed with general or regional anesthesia, with the patient in the lateral decubitus position. Care should be exercised in positioning the patient with supports for the neck, axilla, and upper limbs. Deliberate hypotension will reduce the blood loss during surgery.

Complications include bleeding, nerve damage, and embolization of air, fat, bone, and cement during insertion of the femoral component. Patients are routinely anticoagulated postoperatively to prevent deep venous thrombosis, which

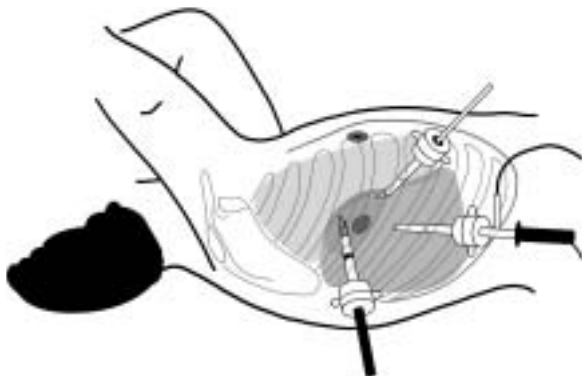


Figure 2-5. Thoracoscopic surgery.

has an impact on the choice of postoperative analgesic technique. In most reports of ambulatory arthroplasty, oral analgesics were used following discharge.

Aesthetic surgery procedures

Abdominoplasty

Abdominoplasty is a common body contouring surgery that may be fairly extensive, consisting of elevation of skin and fat flaps up to the costal margins, umbilical translocation, and musculofascial plication. Patients undergoing abdominoplasty procedures may be healthy or morbidly obese. Obese patients need to be screened for obstructive sleep apnea and other common comorbidities such as hypertension and type II diabetes mellitus. They may require aspiration prophylaxis. Pharmacokinetics is altered in morbidly obese patients, and sedative and opioid medications should be administered with care.

The procedure is usually performed on an inpatient basis; however, a recent publication described a series of 18 ambulatory patients, 16 of whom had their surgery in an office surgery suite under general anesthesia.⁵⁵ All patients received premedication with a COX-2 (cyclooxygenase-2) inhibitor and local anesthetic infiltration at the completion of surgery. Postoperatively, patients were prescribed oral opioids and oral diazepam for discomfort. There were no major complications in the ambulatory group; however, careful patient and facility selection was stressed. (See Chapter 11 for further discussion of office-based abdominoplasty).

Summary

The range of ambulatory surgical procedures continues to grow as pressure to reduce health care costs increases from the federal government, businesses, insurance providers, and patients. This review of the more extensive surgeries that are being introduced to the ambulatory arena is presented together with the special features of these procedures in order to guide the anesthesiologist who will be involved in the management of patients undergoing these surgeries as they become commonplace. It is critical for physicians to control the clinical decisions that affect the safety of our patients, and the involvement of the anesthesiologist in all stages of the perioperative care of this expanding patient population is the key to a successful ambulatory outcome.

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