Thyroid surgery offers definitive treatment for benign thyroid disease with relatively low complication rates. Currently, most thyroid surgery is performed for glands suspicious for carcinoma; however, surgery for benign disease has become a more appealing option for patients as a result of minimally invasive techniques. These techniques can be safely applied for the treatment of benign thyroid disease, resulting in smaller postoperative scars and reduced postoperative pain compared with standard open methods. This chapter includes a detailed discussion of two different minimally invasive approaches for benign thyroid disease.

The thyroid surgeon should have a close working relationship with the endocrinologist or primary care physician, as perioperative medical management is crucial to prevent complications. The management strategy for benign diseases, such as toxic solitary nodules, multinodular goiters, and Graves disease, should be decided by the patient in conjunction with all members of the treating medical team. Although nonsurgical treatment options are discussed briefly in this chapter, a detailed discussion of the medical management of benign thyroid disease can be found in Chapter 7.

Toxic Solitary Nodule

Solitary autonomously functioning toxic nodules are independent of thyroid-stimulating hormone (TSH) control and produce clinical or subclinical hyperthyroidism. Radionuclide imaging displays an increased uptake of radioactive iodine by the toxic nodule. Definitive treatment for the toxic solitary nodule includes sclerosing therapy, iodine-131 (I-131) ablation, and surgical resection. Thionamides offer only temporary control of toxic solitary nodules.

Sclerosing therapy, popular as a treatment modality in Europe, involves the percutaneous injection of ethanol directly into the toxic nodule, typically under ultrasound guidance. Monzani and colleagues reported a permanent cure rate of 70.6% when sclerosing therapy is used for toxic adenomas. Sclerosing therapy, however, may require multiple treatment sessions.

Treatment with radioactive iodine is the most common treatment for toxic solitary nodules in the United States. Doses of I-131 can vary, depending on the size of the toxic nodule. Smaller doses of I-131 are associated with a lower incidence of posttreatment hypothyroidism, but relapse rates are correspondingly higher. The reverse trend is seen with larger treatment doses. Up to 75 to 90% of patients are cured within 3 months of I-131 ablation. Rates of posttreatment hypothyroidism range from 8 to 60%, depending on the dose of I-131. With a typical dose of 20 mCi, approximately 15% of patients require more than one treatment for cure.

Surgical treatment of toxic solitary nodules offers a definitive cure with a very low postoperative risk of hypothyroidism. Complete surgical resection typically involves a unilateral thyroid lobectomy, resulting in resolution of hyperthyroidism. Surgery is preferred for children, adolescents, and pregnant patients with toxic thyroid nodules to avoid the potential long-term risks of radioactive iodine. Large toxic nodules are typically treated with surgery, to obviate the need for the large doses of radioactive iodine that would be required for ablation. Complications are rare after unilateral thyroid lobectomy for benign thyroid disease, with essentially no risk of hypoparathyroidism and a 0.2 to 0.6% risk of permanent vocal cord paralysis.

Multinodular Goiter

Multinodular goiter occurs in 4% of the United States population. Surgery provides definitive treatment with low complication rates and immediate resolution of symptoms associated with upper aerodigestive tract compression. Histologic examination of removed tissue allows the detection of potential malignancy, which is present in approximately 8.3% of cervical and substernal goiters. Large multinodular goiters generally are not amenable to minimally invasive surgical techniques. Substernal goiters are discussed in greater detail in Chapter 9.

Surgery for toxic multinodular goiter may be preferable to I-131 in healthy patients, resulting in the immediate resolution of hyperthyroidism and compressive symptoms when present. Large and often multiple doses of radioactive iodine are required to control hyperthyroidism in toxic multinodular goiter.

Graves Disease

Radioiodine is the most common method used to treat Graves disease in the United States because of the high efficacy, ease of use, and low cost. Radioiodine is contraindicated in patients who are pregnant or nursing. Caution must be exercised when considering treatment with radioiodine in children because of the concern for a subsequent increased risk of malignancy.
Thyroidectomy is usually indicated in patients with Graves disease who have a large goiter or coexistent suspicious thyroid nodules. Mazzaferri reported that well-differentiated thyroid cancer is approximately twice as prevalent in patients with Graves disease as in the general population. Cancer in this setting is associated with higher rates of regional lymph node metastases and local invasion. Surgery is also preferred in pregnant women whose hyperthyroidism is not controlled with antithyroid drugs. The optimal timing for surgery is in the second trimester to minimize the risk to the fetus. When surgery is indicated for Graves disease, total thyroidectomy is promptly curative, with relatively low complication rates. Total thyroidectomy is preferred over subtotal thyroidectomy to avoid the risk of recurrent hyperthyroidism. Total thyroidectomy is associated with a 2 to 3% incidence of transient vocal cord paralysis, which is permanent in 1% of patients, and temporary hypoparathyroidism in 10 to 15% of cases, which is permanent in 2 to 3%.

Preoperative Preparation

In addition to achieving a stable medical state prior to surgery, it is important to ensure that the patient is euthyroid to minimize the risk of thyroid storm, a potential complication of surgery for hyperthyroidism. The pathogenesis of thyroid storm is unclear but is precipitated by stress or trauma such as surgery in hyperthyroid patients and manifests as extreme thyrotoxicosis associated with a hypermetabolic state, resulting in cardiac arrhythmias, hyperpyrexia, congestive heart failure, and cardiovascular collapse. Treatment for hyperthyroidism usually starts 4 to 6 weeks prior to surgery with an antithyroid drug, such as methimazole (10–30 mg/day) or propylthiouracil (100–300 mg, three times daily). Potassium iodide (Lugol solution) may be administered 7 to 10 days prior to surgery in doses of 5 to 10 drops two to three times a day to decrease the vascularity of the thyroid gland. Inorganic iodine treatment inhibits thyroid hormone secretion and decreases thyroid blood flow, possibly reducing bleeding during surgery. Beta-blockers are often added to the preparation regimen to control symptoms of hyperthyroidism such as tachycardia, anxiety, tremor, and heat intolerance. Propranolol, an adrenergic blocking agent, inhibits peripheral conversion of T4 to T3, and is prescribed in doses of 40 to 120 mg, up to four times a day. Propranolol is continued for up to a week after surgery because the half-life of thyroxine is 7 days. Beta-blockers have been used alone for preoperative preparation, although higher rates of perioperative thyrotoxicosis are associated with this single-drug regimen.

Conventional Thyroidectomy

Thyroid lobectomy is the standard surgical procedure for a unilateral solitary nodule. The surgical technique begins with an incision in a relaxed skin tension line, just above the sternal notch. It is preferable to mark the patient preoperatively while he or she is in a sitting position in the holding area, to optimize the location of the incision while the patient is positioned naturally. Dissection is carried down to the subplatysmal fascial plane. The midline of the strap muscles is identified and separated to expose the underlying thyroid gland. The gland is dissected bluntly from the overlying sternothyroid muscle. Medial retraction of the thyroid lobe allows identification of the middle thyroid vein, which is isolated and ligated. The superior pole is isolated and the superior thyroid artery and vein are either ligated individually or as a bundle on the surface of the gland capsule. Care is exercised to avoid injury to the external branch of the superior laryngeal nerve. This nerve is not routinely identified.

Dissection of the recurrent laryngeal nerve (RLN) begins near the inferior pole of the gland, in the tracheoesophageal groove. Identification of the RLN during thyroidectomy reduces the incidence of nerve injury. The right RLN enters the tracheoesophageal groove more obliquely than the left. Identification is facilitated by medial retraction of the thyroid lobe and dissection with blunt elevators in a direction perpendicular to the direction of the nerve (Fig. 8.1).
the nerve is identified by careful dissection, it is followed superiorly. The RLN crosses the inferior thyroid artery in a variable fashion, making the inferior thyroid artery an unreliable landmark for RLN identification. The possibility of a nonrecurrent laryngeal nerve should be considered if the nerve is not located in the tracheoesophageal groove.

The inferior thyroid pole is mobilized and retracted superomedially to identify the inferior parathyroid gland. The gland is preserved along with its blood supply (a branch of the inferior thyroid artery) by meticulous dissection laterally away from the thyroid capsule (Fig. 8.2). The superior parathyroid gland is similarly identified and gently dissected from the thyroid gland. The superior parathyroid glands receive their blood supply from branches of the inferior thyroid artery but may infrequently be supplied by branches of the superior thyroid artery or from an anastomosis between the inferior and superior thyroid arteries. Terminal branches of both the inferior and superior thyroid vessels are ligated as close to the thyroid capsule as possible to ensure preservation of the parathyroid blood supply.

The thyroid gland is dissected free from the posterior suspensory ligament of Berry, the most vulnerable area for RLN injury. The RLN typically passes deep to this ligament; however, it may pass through or in front of the ligament. Division of the Berry ligament should be performed while carefully visualizing the nerve to avoid inadvertent nerve injury. The RLN frequently branches prior to entering the larynx (Fig. 8.3). Up to 65% of RLNs demonstrate extralaryngeal branching, with two to three terminal branches noted in the majority of cases. The thyroid lobe is divided at the isthmus and removed.
If a total thyroidectomy is indicated, the contralateral gland is removed in the same fashion as the ipsilateral lobe. Special attention should be directed to identification and preservation of all parathyroid glands because the patient is at risk for postoperative hypoparathyroidism. Rates of permanent hypoparathyroidism after total thyroidectomy have been reported to occur in approximately 2 to 3% of cases performed by experienced surgeons. Reimplantation of parathyroid tissue of questionable viability is recommended, and has been shown to result in a lower incidence of permanent postoperative hypoparathyroidism.

**Minimally Invasive Techniques**

Minimally invasive techniques can be safely applied for the treatment of benign thyroid disease. Several distinct versions of minimally invasive surgery have been described. The advantages common to these methods include an improved postoperative cosmetic result and reduced postoperative pain compared with conventional open surgery. Two approaches are discussed in this chapter, along with their indications, technical descriptions, and complications.

**Minimally Invasive Nonendoscopic Thyroidectomy**

This technique has been previously described in detail and is particularly valuable for the inexperienced minimal access thyroid surgeon. Transection of the strap muscles can occasionally be done to facilitate exposure within the limited surgical field. Patient selection is important. Obese patients pose a challenge because of a greater depth of the operative field, which may hinder exposure through a smaller incision. The presence of thyroiditis may result in troublesome bleeding and difficult dissection of tissue planes secondary to adhesions. Large multinodular goiters pose a relative contraindication to the use of minimally invasive techniques.

**Surgical Technique**

The patient is positioned with no or only minimal neck extension, and a 3- to 6-cm incision is created in a relaxed skin tension line (the precise length dictated by the clinical circumstances). Again, the location is determined presurgically with the patient sitting upright. The sternohyoid and sternothyroid musculature is exposed and either retracted laterally or in some cases transected horizontally to expose the thyroid gland.

The superior pole of the thyroid is first isolated and the vessels are ligated with the ultrasonic shears (Harmonic Shears, model #CS-14C or ACE 23P; Ethicon Endo-Surgery). The superior lobe is mobilized, and the superior parathyroid gland identified. The middle thyroid vein is identified and ligated, and the inferior lobe is mobilized sufficiently to identify the inferior parathyroid gland and the recurrent laryngeal nerve. The inferior pole vessels are ligated at the capsule of the thyroid gland, and the gland is dissected off the trachea. During this dissection, the recurrent laryngeal nerve is visualized to avoid injury. The isthmus is divided adjacent to the contralateral lobe for unilateral lobectomy. For total thyroidectomy, the dissection is performed in the same manner on the contralateral thyroid lobe.

Following thyroidectomy, the sternothyroid and sternohyoid muscles are reapproximated (if they were transected) using interrupted figure-of-eight Vicryl sutures (Ethicon, Inc., Somerville, NJ). The subcutaneous tissues are approximated with interrupted Vicryl sutures, and the skin is closed with liquid skin adhesive (Dermabond, Ethicon, Inc.). A drain is rarely required.

This minimally invasive approach is safe with no increased risk of permanent hypocalcemia or recurrent laryngeal nerve paralysis compared with conventional open surgery. Cosmetic results are superior, with an incision as small as 3.0 cm.

**Endoscopic Thyroidectomy**

**Indications**

The endoscopic or minimally invasive video-assisted thyroidectomy (MIVAT) was pioneered in Italy and subsequently introduced in North America. The indications for endoscopic thyroidectomy are relatively narrow, and include thyroid nodules no larger than 25 to 30 mm in glands with volume less than 20 cc. Some authors have expanded these indications to include patients with Graves disease whose thyroid glands are smaller than 20 to 30 cc, and those with low-risk papillary thyroid carcinomas as large as 35 mm. A prospective, randomized study by Miccoli et al found that a MIVAT is at least as thorough and complete as open thyroidectomy for patients with small, isolated papillary thyroid carcinoma (less than 3.5 cm) based on thyroid uptake studies and thyroglobulin levels. Patients who require lymph node dissection or have invasive thyroid carcinoma are generally not considered candidates for endoscopic approaches, although central compartment neck dissection has been described using the minimally invasive technique. A history of thyroiditis, previous neck surgery or irradiation, and substernal extension are relative contraindications to the endoscopic technique. In high-volume institutions, between 12 and 29% of patients undergoing thyroidectomies are candidates for an endoscopic approach.

**Technical Considerations**

The pursuit of an endoscopic approach has been greatly facilitated by ultrasonic technology. The Harmonic scalpel cuts and coagulates with ultrasonic vibrations of the blade at a speed of 55,500 Hz. Mechanical vibration from the device creates frictional energy, denaturing proteins by breaking the hydrogen bonds at temperatures between 50° and 100°C. A coagulum, formed from denatured proteins, seals vessels of up to 5 mm in diameter. No electrical energy is transferred to the patient, reducing the risk of thermal injury to...
important structures such as the RLN and parathyroid glands.49 - 52 Other essential instruments utilized during endoscopic thyroidectomy include deep retractors, blunt elevators, and a 5-mm 30-degree laparoscope.

The operating room table should be rotated 180 degrees to allow ample space for the surgeon and two assistants (one holding the endoscope, and one holding retractors), as well as the endoscopic and ultrasonic equipment (Fig. 8.4).

Surgical Technique

The patient is marked while in the upright position for a 15- to 30-mm horizontal cervical incision in a relaxed skin tension line at the midline. In the operating room, the patient is placed in the supine position with no or only slight cervical extension without a shoulder roll. The incision is made through the skin and subcutaneous tissues (Fig. 8.5), and the midline raphe between the strap muscles is identified. A protected and extended electrocautery tip facilitates dissection at midline down to the thyroid isthmus.

A plane between the sternothyroid muscle and the thyroid gland is developed bluntly with an elevator (Fig. 8.6). The gland is carefully mobilized away from the sternothyroid muscle. The middle thyroid vein branches are isolated and ligated with the ultrasonic shears. Retractors are placed against the sternothyroid muscle and the thyroid gland to facilitate visualization of the superior thyroid vessels.

The endoscopic component of the technique begins as the laparoscope is angled upward just within the wound for visualization of the superior pole. No carbon dioxide insufflation is necessary. The operating room setup ensures appropriate placement of monitors for the surgeon and assistant (Fig. 8.4).

A small portion of the sternothyroid muscle is divided with the ultrasonic shears superficial to the superior pole vessels to improve visualization. This is the only muscle that is cut during the operation. Dissection and isolation of the superior thyroid artery and vein is performed using blunt elevators.

The ultrasonic shears are used to seal and divide the vessels (Fig. 8.7), while a suction elevator evacuates the steam created. Alternatively, the terminal branches of the superior pole vessels may be ligated in a bundle as they enter the capsule of the gland. The superior laryngeal nerve may be visualized as it crosses lateral to medial in relation to the vessels. The superior parathyroid gland is identified and dissected away from the thyroid gland as the gland is mobilized inferiorly.

The laparoscope is then angled downward, and the inferior pole of the thyroid is mobilized and retracted medially to facilitate endoscopic identification of the RLN. The nerve is identified in the tracheoesophageal groove and traced out for a length of 15 to 20 mm. The inferior parathyroid gland is identified and gently mobilized away from the thyroid gland. Once the recurrent laryngeal nerve is identified, the inferior thyroid artery and vein may be isolated, sealed, and divided.

The remaining steps are performed in an open fashion. The isthmus is dissected from the trachea and divided using either electrocautery or the ultrasonic shears. Sequential placement of a series of clamps on the superior pole of the gland is accomplished to allow delivery of the thyroid (Fig. 8.8). Any remaining attachments at the superior pole are divided,
**Fig. 8.5** An incision is made approximately 2 cm above the sternal notch in a relaxed skin tension line at midline.

**Fig. 8.6** A plane between the sternothyroid muscle and the thyroid gland is developed bluntly with an elevator.
Fig. 8.7 Ultrasonic shears seal and divide the superior thyroid artery and vein after they are isolated individually with a pediatric right-angle clamp. An alternate method is to ligate the terminal branches in a bundle as they enter the capsule of the gland.

Fig. 8.8 Sequential placement of clamps, on the superior pole, facilitates the delivery of the thyroid gland.

Fig. 8.9 The recurrent laryngeal nerve is traced to its entrance at the larynx, and the connective tissue attachments between the gland and trachea (the ligament of Berry) are divided using the ultrasonic shears. Larger vessels individually ligated.
and the gland is mobilized inferiorly and exteriorized. The recurrent laryngeal nerve is traced to its entrance at the larynx, and the ligament of Berry is divided using the ultrasonic shears (Fig. 8.9).

Surgicel is placed into the thyroid bed, and the strap muscles are reapproximated with a figure-of-eight suture of 3–0 Vicryl (Fig. 8.10). A single 4–0 Vicryl suture is used to approximate the subcutaneous tissues, and Dermabond is used to close the skin. No drain or skin sutures are required. Patients are usually discharged after recovering in the postanesthesia unit (see Chapter 22).

**Complications**

The complication rates associated with endoscopic thyroid surgery are similar to those described for conventional surgery, including the rates of transient and permanent recurrent laryngeal nerve palsy, transient and permanent hypocalcemia, postoperative hematoma, and wound infection.29,30

**Conclusion**

Improvements in the technique of thyroidectomy have made thyroid surgery a more appealing option in the treatment of benign thyroid disease. Minimally invasive thyroidectomy has been demonstrated to be safe and is cosmetically superior to conventional open techniques. Technological advances will undoubtedly fuel continued refinements in minimal access surgery.

**References**

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