THYROID AND PARATHYROID PROCEDURES

Gregg H. Jossart, M.D., F.A.C.S., and Orlo H. Clark, M.D., F.A.C.S.

Thyroidectomy

OPERATIVE PLANNING

If the patient has had any hoarseness or has undergone a neck operation before, indirect or direct (ideally, fiberoptic) laryngoscopy is essential to determine whether the vocal cords are functioning normally. All patients scheduled for thyroidectomy should be euthyroid at the time of operation; in all other respects, they should be prepared as they would be for any procedure calling for general anesthesia.

Optimum exposure of the thyroid is obtained by placing a sandbag between the scapula and a foam ring under the occiput; in this way, the neck is extended, and the thyroid can assume a more anterior position. The head must be well supported to prevent postoperative posterior neck pain. The patient is placed in a 20° reverse Trendelenburg position. The skin is prepared with 1% iodine or chlorhexidine.

OPERATIVE TECHNIQUE

General Troubleshooting

Thyroid and parathyroid operations should be performed in a blood-free field so that vital structures can be identified. Operating telescopes (magnification: \( \times 2.5 \) or \( \times 3.5 \)) are also recommended because they make it easier to identify the normal parathyroid glands and the recurrent laryngeal nerve. If bleeding occurs, pressure should be applied. The vessel should be clamped only if (1) it can be precisely identified or (2) the recurrent laryngeal nerve has been identified and is not in close proximity to the vessel.

As a rule, dissection should always be done first on the side where the suspected tumor is; if there is a problem with the dissection on this side, a less than total thyroidectomy can be performed on the contralateral side to prevent complications. There is, however, one exception to this rule: if the tumor is very extensive, the surgeon will sometimes find it easier to do the dissection on the “easy” side first to facilitate orientation with respect to the trachea and the esophagus.

Step 1: Incision and Mobilization of Skin Layers

A Kocher transverse incision paralleling the normal skin lines of the neck is made 1 cm caudad to the cricoid cartilage [see Figure 1]. As a rule, the incision should be about 4 to 6 cm long and should extend from the anterior border of one sternocleidomastoid muscle to the anterior border of the other and through the platysma. Five straight Kelly clamps are placed on the dermis to facilitate dissection, which proceeds first cephalad in a subplatysmal plane anterior to the anterior jugular veins and posterior to the platysma to the level of the thyroid cartilage notch and then caudad to the suprasternal notch. Skin towels and a self-retaining retractor are then applied.

Troubleshooting Placing the incision 1 cm below the cricoid locates it precisely over the isthmus of the thyroid gland. The course of the incision should conform to the normal skin lines or creases. The length of the incision should be modified as necessary for good exposure. Patients with short, thick necks, low-lying thyroid glands, or large thyroid tumors require longer incisions than those with long, thin necks and small tumors. Patients whose necks do not extend also require longer incisions for adequate exposure. A sterile marking pen should be used to mark the midline of the neck, the level at which the incision should be made (i.e., 1 cm below the cricoid), and the lateral margins of the incision (which should be at equal distances from the midline so that the incision will be symmetrical). A scalpel should never be used to mark the neck: doing so will leave an unsightly scar in some patients. To mark the incision site itself, a 2-0 silk tie should be pressed against the neck [see Figure 1].

The upper flap is dissected first by placing five straight Kelly clamps on the dermis and retracting anteriorly and superiorly. Lateral traction with a vein retractor or an Army-Navy retractor

Figure 1 The initial incision in a thyroidectomy is made 1 cm below the cricoid cartilage and follows normal skin lines. A sterile marking pen is used to mark the midline of the neck, the level of the incision, and the lateral borders of the incision. A 2-0 silk tie is pressed against the neck to mark the incision site itself.
helps identify the semilunar plane for dissection. This blood-free plane is deep to the platysma and superficial to the anterior jugular veins. Cephalad dissection can be done quickly with the electrocautery or a scalpel, and lateral dissection can be done bluntly. The same principles are applied to dissection of the lower flap. In thin patients, the surgeon must be careful not to dissect through the skin from within, especially at the level of the thyroid cartilage.

**Step 2: Midline Dissection and Mobilization of Strap Muscles**

The thyroid gland is exposed via a midline incision through the superficial layer of deep cervical fascia between the strap muscles. Because the strap muscles are farthest apart just above the suprasternal notch, the incision is begun at the notch and extended to the thyroid cartilage.3

On the side where the thyroid nodule or the suspected parathyroid adenoma is located, the more superficial sternohyoid muscle is separated from the underlying sternothyroid muscle by blunt dissection, which is extended laterally until the ansa cervicalis becomes visible on the lateral edge of the sternothyroid muscle and on the medial side of the internal jugular vein. The sternothyroid muscle is then dissected free from the thyroid and the prethyroidal fascia by blunt or sharp dissection until the middle thyroid vein or veins are encountered laterally.

A 2-0 silk suture is placed deeply through the thyroid lobe for retraction to facilitate exposure. This stitch should never be placed through the thyroid nodule: doing so could cause seeding of thyroid cancer cells. The thyroid is retracted anteriorly and medially, and the carotid sheath is also retracted to facilitate exposure of the area posterolateral to the thyroid, where the parathyroid glands and the recurrent laryngeal nerves are situated. The middle thyroid veins are divided to give better exposure behind the superior portion of the thyroid lobe. The superior pole vessels are individually identified, skeletonized, double- or triple-clamped, ligated, and divided low on the thyroid gland. To prevent injury to the external laryngeal nerve, the vessels are divided and ligated on the thyroid surface, the thyroid is retracted laterally and caudally, and dissection is carried out on the medial edge of the thyroid gland and lateral to the cricothyroid muscle. As alternatives to

**Troubleshooting**

As a rule, it is not necessary to divide the strap muscles; however, if they are adherent to the underlying thyroid tumor, the portion of the muscle that is adhering to the tumor should be sacrificed and allowed to remain attached to the thyroid. Separation of the sternohyoid muscle from the sternothyroid muscle provides better exposure of the operative field. The middle thyroid veins should be cleaned of adjacent tissues to prevent any injury to the recurrent laryngeal nerve when these veins are ligated and divided. It is always safest to mobilize tissues parallel to the recurrent laryngeal nerve.

**Step 3: Division of Isthmus**

When a thyroid lobectomy is to be performed, the isthmus of the thyroid gland is usually divided with Dandy or Colodny clamps at an early point in dissection to facilitate the subsequent mobilization of the thyroid gland. The thyroid tissue that is to remain is oversewn with a 2-0 silk ligature. To minimize the chance of invasion into the trachea or to avoid a visible mass in patients with compensatory thyroid hypertrophy, thyroid tissues should not be left anterior to the trachea.

**Troubleshooting**

With larger glands, we divide the isthmus first. This step facilitates the lateral dissection by making the gland more mobile.

**Step 4: Mobilization of Thyroid Gland and Identification of Upper Parathyroid Glands**

Once the isthmus has been divided, dissection is continued superiorly, laterally, and posteriorly with a small peanut sponge on a clamp. The superior thyroid artery and veins are identified by retracting the thyroid inferiorly and medially. The tissues lateral to the upper lobe of the thyroid and medial to the carotid sheath can be mobilized caudally to the cricothyroid muscle; the recurrent laryngeal nerve enters the cricothyroid muscle at the level of the cricoid cartilage, first passing through Berry’s ligament [see Figure 4]. The superior pole vessels are individually identified, skeletonized, double- or triple-clamped, ligated, and divided low on the thyroid gland [see Figure 5]. To prevent injury to the external laryngeal nerve, the vessels are divided and ligated on the thyroid surface, the thyroid is retracted laterally and caudally, and dissection is carried out on the medial edge of the thyroid gland and lateral to the cricothyroid muscle. As alternatives to

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Figure 2  To expose the thyroid, a midline incision is made through the superficial layer of deep cervical fascia between the strap muscles. The incision is begun at the suprasternal notch and extended to the thyroid cartilage.3

Figure 3  The middle thyroid veins are divided to give better exposure behind the superior portion of the thyroid lobe.2
sutures, devices such as the Harmonic Scalpel (Ethicon Endo-Surgery, Inc.), the Ligasure Precise (Valleylab), and the Hem-o-lok clip (Weck Closure Systems) may be used to control vessels.

The tissues posterior and lateral to the superior pole that have not already been mobilized can now be easily swept by blunt dissection away from the thyroid gland medially and anteriorly and away from the carotid sheath laterally. The upper parathyroid gland is often identified at this time at the level of the cricoid cartilage.

Troubleshooting
It is essential to keep from injuring the external laryngeal nerve. This nerve is the motor branch of the superior laryngeal nerve and is responsible for tensing the vocal cords; it is also known as the high note nerve or the Amelita Galli-Curci nerve. In about 80% of patients, the external laryngeal nerve runs on the surface of the cricothyroid muscle; in about 10%, it runs with the superior pole vessels; and in the remaining 10%, it runs within the cricothyroid muscle. Given that this nerve is usually about the size of a single strand of a spider web, one should generally try to avoid it rather than to identify it. Injury to the external laryngeal nerve occurs in as many as 10% of patients undergoing thyroidectomy. The best ways of preventing such injury are (1) to provide gentle traction on the thyroid gland in a caudal and lateral direction and (2) to ligate the superior pole vessels directly on the capsule of the upper pole individually and low on the thyroid gland rather than to cross-clamp the entire superior pole pedicle.

The internal laryngeal nerve is the sensory branch of the superior laryngeal nerve; it provides sensory innervation to the posterior pharynx. Injury to this nerve can result in aspiration. Because the internal laryngeal nerve typically is cephalad to the area of dissection during thyroidectomy and runs cephalad to the lateral portion of the thyroid cartilage, it usually is at risk only when the surgeon dissects cephalad to the thyroid cartilage. Such dissection is necessary only when laryngeal mobilization is performed to relieve tension on the tracheal anastomosis after tracheal resection.

Step 5: Identification of Recurrent Laryngeal Nerves and Lower Parathyroid Glands

When the thyroid lobe is further mobilized, the lower parathyroid gland is usually seen; this gland is almost always located anterior to the recurrent laryngeal nerve and is usually located inferior to where the inferior thyroid artery crosses the recurrent laryngeal nerve [see Figure 6]. The carotid sheath is retracted laterally, and the thyroid gland is retracted anteriorly and medially. This retraction puts tension on the inferior thyroid artery and consequently on the recurrent laryngeal nerve, thereby facilitating the identification of the nerve. The recurrent laryngeal nerve is situated more medially on the left (running in the tracheoesophageal groove) and more obliquely on the right. Dissection should proceed cephalad along the lateral edge of the thyroid. Fatty and lymphatic tissues immediately adjacent to the thyroid gland are swept from it with a peanut sponge on a clamp, and small vessels are ligated. No tissue should be transected until one is sure that it is not the recurrent laryngeal nerve.

Troubleshooting
The upper parathyroid glands are usually situated on each side of the thyroid gland at the level where the recurrent laryngeal nerve enters the cricothyroid muscle [see Figure 6]. Because the recurrent laryngeal nerve enters the cricothyroid muscle at the level of the cricoid cartilage, the area cephalad to the cricothyroid cartilage is relatively safe.

The right and left recurrent laryngeal nerves must be preserved during every thyroid operation. Although both nerves enter at the posterior medial position of the larynx in the cricothyroid muscle, their courses vary considerably. The right recurrent laryngeal nerve takes a more oblique course than the left recurrent laryngeal nerve and may pass either anterior or

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**Figure 4** The recurrent laryngeal nerve enters the cricothyroid muscle at the level of the cricoid cartilage, first passing through Berry's ligament.²

**Figure 5** The superior pole vessels should be individually identified and ligated low and laterally on the thyroid gland to minimize the chances of injury to the external laryngeal nerve.²
Nerve
Laryngeal
Recurrent
Artery
Thyroid

In young persons, the artery usually is readily in-ferent to where the inferior thyroid artery crosses this nerve.2

posterior to the inferior thyroid artery. In about 0.5% of persons, the right recurrent laryngeal nerve is in fact nonrecurrent and may enter the thyroid from a superior or lateral direction.1 On rare occasions, both a recurrent and a nonrecurrent laryngeal nerve may be present on the right. The left recurrent laryngeal nerve almost always runs in the tracheoesophageal groove because of its deeper origin within the thorax as it loops around the ductus arteriosus. Either recurrent laryngeal nerve may branch before entering the larynx; the left nerve is more likely to do this. Such branching is important to recognize because all of the motor fibers of the recurrent laryngeal nerve are usually in the most medial branch.

In identifying the recurrent laryngeal nerves, it is helpful to remember that they are supplied by a small vascular plexus and that a tiny vessel runs parallel to and directly on each nerve [see Figures 4 and 6]. In young persons, the artery usually is readily distinguished from the recurrent laryngeal nerve; however, in older persons with arteriosclerosis, the white-appearing artery may be mistaken for a nerve, and thus the nerve may be injured as a result of the misidentification. Lateral traction on the carotid sheath and medial and anterior traction on the thyroid gland place tension on the inferior thyroid artery; this maneuver often helps identify the recurrent laryngeal nerve where it courses lateral to the midpoint of the thyroid gland. One should, however, be careful not to devascularize the inferior parathyroid glands by dividing the lateral vascular attachments: to remove the thyroid lobe, it is best to divide the vessels directly on the thyroid capsule to preserve the blood supply to the parathyroid glands. It is usually safest to identify the recurrent laryngeal nerve low in the neck and then to follow it to where it enters the cricothyroid muscle through Berry’s ligament. The recurrent laryngeal nerves can usually be palpated through the surrounding tissue in the neck; they feel like a taut ligature of approximately 2-0 gauge.

Parathyroid glands should be swept from the thyroid gland on as broad a vascular pedicle as possible to prevent devascularization. When it is unclear whether a parathyroid gland can be saved on its own vascular pedicle, one should biopsy the gland to confirm that it is parathyroid and then autotransplant it in multiple 1 × 1 mm pieces into separate pockets in the sternocleidomastoid muscle. At times, it is preferable to clip the blood vessels running from the thyroid to the parathyroid glands rather than to clamp and tie them. Clipping not only marks the parathyroid gland (which is useful if another operation subsequently becomes necessary) but also enables the gland to remain with minimal manipulation and with its remaining blood supply preserved.

In patients who have extensive thyroid tumors or who require reoperation, extensive scarring is often present. For some of these patients, it is preferable to identify the recurrent laryngeal nerve from a medial approach by dividing the isthmus with Colodny clamps and ligating and dividing the superior thyroid vessels. By carefully dissecting the thyroid away from the trachea, one can identify the recurrent laryngeal nerve at the point where its position is most consistent (i.e., at its entrance into the larynx immediately posterior to the cricothyroid muscle).

The most difficult part of dissection in a thyroidectomy is the part that involves Berry’s ligament, which is situated at the posterior portion of the thyroid gland just caudal to the cricoid cartilage [see Figure 4]. A small branch of the inferior thyroid artery traverses the ligament, as do one or more veins from the thyroid gland. If bleeding occurs during this part of the dissection, it should be controlled by applying pressure with a gauze pad. Nothing should be clamped in this area until the recurrent laryngeal nerve is identified. In some patients (about 15%), the peduncle of Zuckermandl, a small protuberance of thyroid tissue on the right, tends to obscure the recurrent laryngeal nerve at the level of Berry’s ligament.

**Step 6: Mobilization of Pyramidal Lobe**

The pyramidal lobe is found in about 80% of patients. It extends in a cephalad direction, often through the notch in the thyroid cartilage to the hyoid bone. One or more lymph nodes are frequently found just cephalad to the isthmus of the thyroid gland over the cricothyroid membrane (so-called Delphian nodes) [see Figure 7]. The pyramidal lobe is mobilized by retracting it caudally and by dissecting immediately adjacent to it in a cephalad direction. Small vessels are coagulated or ligated.

**Step 7: Thyroid Resection**

Once the parathyroid glands have been carefully swept or dissected from the thyroid gland and the recurrent nerve has been identified, the thyroid lobe can be quickly resected. For total thyroidec-tomy, the same operation is done again on the other side.

**Troubleshooting** The thyroid lobe or gland should be carefully examined after removal. If a parathyroid gland is identified, a biopsy of it should be performed to confirm that it is parathyroid and then autotransplanted. In a thyroid procedure, every parathyroid gland should be treated as if it is the last one, and at least one parathyroid gland should be definitely identified. As a rule, biopsies should not be performed on normal parathyroid glands during a thyroid procedure.

**Step 8: Closure**

The sternothyroid muscles are approximated with 4-0 absorbable sutures, and a small opening is left in the midline at the suprasternal notch to make any bleeding that occurs more evident and to allow the blood to exit. The sternohyoid muscles are
reapproximated in a similar fashion, as is the platysma. The skin is then closed with butterfly clips, which are hemostatic and inexpensive and permit precise alignment of the skin edges. In children, the skin is usually closed with a subcuticular stitch or a tissue adhesive (e.g., Indermil; Tyco Healthcare), or both, instead. A sterile pressure dressing is applied.

**Special Concerns**

**Invasion of the trachea or the esophagus** On rare occasions, thyroid or parathyroid cancers may invade the trachea or the esophagus. As much as 5 cm of the trachea can be resected safely, without impairment of the patient’s voice. If the invasion is not extensive and is confined to the anterior portion of the trachea, a small section of the trachea that contains the tumor should be excised, and a tracheostomy may be placed at the site of resection. If the invasion is more extensive or occurs in the lateral or posterior portion of the trachea, a segment of the trachea measuring several centimeters long is resected, and the remaining segments are reanastomosed. To prevent tension on the anastomosis, the trachea should be mobilized before resection, the recurrent laryngeal nerves should be preserved and mobilized from the trachea, and the mylohyoid fascia and muscles should be divided above the thyroid cartilage to drop the cartilage. Care must be taken not to injure the internal laryngeal nerves during this dissection, given that these nerves course from lateral to medial just above the lateral aspects of the thyroid cartilage. After resection, the trachea is reapproximated with 3-0 Maxon sutures. One or two Penrose drains should be left near the resection site to allow air to exit. The drains are removed after several days, when there is no more evidence of air leakage.

If the esophagus is invaded by tumor, the muscular wall of the esophagus can be resected along with the tumor, with the inner esophageal layer left in place.

**Neck dissection for nodal metastases** Lymph nodes in the central neck (medial to the carotid sheath) are frequently involved in patients with papillary, medullary, and Hürthle cell cancer. These nodes should be removed without injury to the parathyroid glands or the recurrent laryngeal nerves. In most patients, it is relatively easy to remove all tissue between the carotid sheath and the trachea. In some patients with extensive lymphadenopathy, it is necessary to remove the parathyroids, perform biopsies on them to confirm that they are in fact parathyroid, and autotransplant them into the sternocleidomastoid muscle.

When lymph nodes are palpable in the lateral neck, a modified neck dissection is performed through a lateral extension of the Kocher collar incision to the anterior margin of the trapezius muscle (a MacFee incision). The jugular vein, the spinal accessory nerve, the phrenic nerve, the vagus nerve, the cervical sympathetic nerves, and the sternocleidomastoid muscle are preserved unless they are directly adherent to or invaded by tumor.

In patients with medullary thyroid cancer, a meticulous and thorough central neck dissection is necessary. When a primary medullary tumor is larger than 1 cm or the central neck nodes are obviously involved, these patients will also benefit from a lateral modified radical neck dissection (with the structures just mentioned preserved). During the dissection, all fibrofatty lymph node tissues should be removed from the level of the clavicle to the level of the hyoid bone. The deep dissection plane is developed anterior to the scalenus anticus muscle, the brachial plexus, and the scalenus medius muscle. The phrenic nerve runs obliquely on the scalenus anticus muscle. The cervical sensory nerves can usually be preserved unless there is extensive tumor involvement.

**Median sternotomy** A median sternotomy is rarely necessary for removal of the thyroid gland because the blood supply to the thyroid gland, the thymus, and the lower parathyroid glands derives primarily from the inferior thyroid arteries in the neck. Metastatic lymph nodes frequently extend inferiorly in the tracheoesophageal groove into the superior mediastinum; these nodes can almost always be removed through a cervical incision without any need for a sternotomy. On rare occasions, metastatic nodes spread to the aortic pulmonary window and can be identified preoperatively on CT or MRI. If a median sternotomy proves necessary, the sternum should be divided to the level of the third intercostal space and then laterally on one side at the space between the third rib and the fourth. Median sternotomy provides excellent exposure of the upper anterior mediastinum and the lower neck.

**POSTOPERATIVE CARE**

The duration of a thyroid operation is 1 to 3 hours, depending on the size and invasiveness of the tumor, its vascularity, and the location of the parathyroid glands. Postoperatively, the patient is kept in a low Fowler position with the head and shoulders elevated 10° to 20° for 6 to 12 hours to maintain negative pressure in the veins. The patient typically resumes eating within 3 to 4 hours, and an antiemetic is ordered as needed (many patients experience postoperative nausea and emesis).

The serum calcium level is measured approximately 5 to 8 hours after operation in patients who have undergone bilateral procedures; no tests are required in those who have undergone unilateral procedures. On the first morning after the thyroidectomy, the serum calcium and serum phosphate levels are measured. If the patient is still hospitalized on postoperative day 2, these tests are repeated on the second morning as well. Oral calcium supplements are given if the serum calcium is below 7.5 mg/dl or if the patient experiences perioral numbness or tingling. A low serum phosphate level (< 2.5 mg/dl) usually is a sign of so-called bone hunger and suggests that there is little
reason to be concerned about permanent hypoparathyroidism, whereas a high level (> 4.5 mg/dl) should prompt concern about permanent hypoparathyroidism.

The surgical clips are removed on postoperative day 1, and tissue adhesive or Steri-Strips are applied to prevent tension on the healing wound. (If Steri-Strips are used, they are removed on day 10.) Patients usually are discharged on the first day, are given a prescription for thyroid hormone (L-thyroxine, 0.1 to 0.2 mg/day orally) if the procedure was more extensive than a thyroid lobectomy, and are told to take calcium tablets for any tingling or muscle cramps. Patients with papillary, follicular, or Hürthle cell cancer should receive enough L-thyroxine to keep their serum levels of thyroid-stimulating hormone (TSH) below 0.1 mIU/ml. On postoperative day 10, the pathology is reviewed, and further management is discussed in the light of the pathologic findings. In patients with thyroid cancer, values for serum calcium, TSH, and thyroglobulin are obtained; in patients with coexisting hyperparathyroidism, values for serum calcium, phosphorus, and parathyroid hormone (PTH) are obtained.

COMPLICATIONS

The following are the most significant complications of thyroidectomy.

1. Injury to the recurrent laryngeal nerve. Bilateral injury to the recurrent laryngeal nerve may result in vocal cord paresis and stridor and may have to be treated with a tracheostomy.

2. Hypoparathyroidism. This complication may arise as the result of removal of, injury to, or devascularization of the parathyroid glands. As noted [see Operative Technique, above], we recommend leaving parathyroid glands on their own vascular pedicle; however, if one is concerned about possible devascularization of a parathyroid, biopsy should be performed on the gland to confirm its identity and then autotransplanted in 1 × 1 mm pieces into separate pockets in the sternocleidomastoid muscle.

3. Bleeding. Postoperative bleeding can be life threatening in that it can compromise the airway. Any postoperative respiratory distress can be thought of as attributable to a neck hematoma until proved otherwise. Most bleeding occurs within four hours of operation, and virtually all occurs within 24 hours.

4. Injury to the external laryngeal nerve [see Operative Technique, above].

5. Infection. This complication is quite rare after thyroidectomy. Any patient with acute pharyngitis should not undergo this procedure.

6. Seroma. Most seromas are small and resorb spontaneously; some must be aspirated.

7. Keloid. Keloid formation after thyroidectomy is most common in African-American patients and in patients with a history of keloids.

8. There are a number of miscellaneous complications that are somewhat less common.

OUTCOME EVALUATION

Most patients can return to work or full activity in 1 to 2 weeks. Patients with benign lesions who have undergone hemithyroidectomy may or may not require thyroid hormone; those with multinodular goiter, thyroiditis, or occult papillary cancer typically do, whereas those with follicular adenoma typically do not. Patients who have undergone total or near-total thyroidectomy will require thyroid hormone. Patients with papillary or follicular cancer who have undergone total or near-total thyroidectomy appear to benefit from radioactive iodine scanning and therapy. (It is necessary to discontinue L-thyroxine for 6 to 8 weeks and L-triiodothyronine for 2 weeks before scanning.) Those considered to be at low risk (age < 45 years, tumor confined to the thyroid and not invasive, and tumor diameter < 4 cm) may receive radioactive iodine on an outpatient basis in a dose of approximately 30 mCi. Those who are considered to be at high risk should receive approximately 100 to 150 mCi. Long-term (20-year) mortality is about 4% in low-risk patients and about 40% in high-risk patients. Serum thyroglobulin levels should be determined before and after discontinuance of thyroid hormone; such levels are very sensitive indicators of persistent thyroid disease after total thyroidectomy.

Parathyroidectomy

OPERATIVE PLANNING

The preparation for parathyroidectomy is the same as that for thyroidectomy. Patients who have profound hypercalcemia (serum calcium ≥ 12.5 mg/dl) or mild to moderate renal failure should be vigorously hydrated and given furosemide before operation. On rare occasions, such patients require additional treatment—for example, administration of diphenhydrine, mithramycin, or calcitonin. Any electrolyte abnormalities (e.g., hypokalemia) should be corrected.

We recommend either bilateral exploration or focused exploration with intraoperative PTH assay for most patients undergoing initial operations for primary sporadic hyperparathyroidism. The latter approach can be taken only when the abnormal gland has been identified by sestamibi scanning. For patients with familial primary hyperparathyroidism or secondary hyperparathyroidism, bilateral exploration is recommended because most of these patients have multiple abnormal parathyroid glands.

Preoperative localization studies (e.g., ultrasonography, MRI, sestamibi scanning, and CT scanning) are generally unnecessary: they provide useful information in about 75% of patients, but they are often not considered cost-effective, because an experienced surgeon can treat hyperparathyroidism successfully 95% to 98% of the time. Such studies are, however, essential when reoperation for persistent or recurrent hyperparathyroidism is indicated and when a focused approach with intraoperative PTH assay is to be used. We do not believe that using the gamma probe is any better than preoperative sestamibi scanning. All patients requiring reoperation should undergo direct or indirect laryngoscopy before operation for evaluation of vocal cord function.

OPERATIVE TECHNIQUE

Steps 1 through 4

Steps 1, 2, 3, and 4 of a parathyroidectomy are virtually identical to steps 1, 2, 4, and 5 of a thyroidectomy (see above), and essentially the same troubleshooting considerations apply.

Troubleshooting About 85% of people have four parathyroid glands, and in about 85% of these persons, the parathyroids are situated on the posterior lateral capsule of the thyroid. Normal parathyroid glands measure about 3 × 3 × 4 mm and are light brown in color. The upper parathyroid glands are more posterior (i.e., dorsal) and more constant in position (at the level of the cricoid cartilage) than the lower parathyroid glands, which typi-
cally are more anteriorly placed (on the posterior-lateral surface of the thyroid gland). Both the upper and the lower parathyroid glands are supplied by small branches of the inferior and superior thyroid arteries in most patients. About 15% of parathyroid glands are situated within the thymus gland, and about 1% are intrathyroidal. Other abnormal sites for the parathyroid glands are (1) the carotid sheath, (2) the anterior and posterior mediastinum, and (3) anterior to the carotid bulb or along the pharynx (undescended parathyroids).

The upper parathyroid glands are usually lateral to the recurrent laryngeal nerve at the level of Berry’s ligament; their position makes them generally easier to preserve during thyroidectomy and easier to find during both parathyroid and thyroid surgery. When the upper parathyroids are not found at this site, they often can be found in the tracheoesophageal groove or in the posterior mediastinum along the esophagus. The lower parathyroid glands are almost always situated anterior to the recurrent laryngeal nerves and caudal to where the recurrent laryngeal nerve crosses the inferior thyroid artery; they may be surrounded by lymph nodes. When the lower parathyroids are not found at this site, they usually can be found in the anterior mediastinum (typically in the thymus or the thymic fat).

**Step 5: Parathyroid Resection**

Abnormal parathyroid glands are removed. In about 80% of patients with primary hyperparathyroidism, one parathyroid gland is abnormal; in about 15%, all glands are abnormal (diffuse hyperplasia); and in about 5%, two or three glands are abnormal and one or two normal. Parathyroid cancer occurs in about 1% of patients with primary hyperparathyroidism. About 50% of patients with parathyroid cancer have a palpable tumor, and most exhibit profound hypercalcemia (serum calcium ≥ 14.0 mg/dl).

**Troubleshooting** In some patients, parathyroid tumors and hyperplastic parathyroid glands are difficult to find. If this is the case, the first step is to explore the sites where parathyroids are usually located, near the posterolateral surface of the thyroid gland. (About 80% of parathyroid glands are situated within 1 cm of the point where the inferior thyroid artery crosses the recurrent laryngeal nerve.) When a lower gland is missing from the usual location, it is likely to be found in the thymus; this possibility can be confirmed by mobilizing the thymus from the anterior-superior mediastinum. In all, about 15% of parathyroid glands are found within the thymus. If an upper parathyroid gland cannot be located, one should look not only far behind the thyroid gland superiorly but also in a paraesophageal position down into the posterior mediastinum. A thyroid lobectomy or thyroidectomy should be done on the side where fewer than two parathyroid glands have been located and no abnormal parathyroid tissue has been identified. The carotid sheath and the area posterior to the carotid, as well as the retroesophageal area, should also be explored. In rare cases, there may be an undescended parathyroid tumor anterior to the carotid bulb.

Although we do not recommend routine biopsy of more than one normal-appearing parathyroid gland, we do recommend biopsy (not removal) and marking of all normal parathyroid glands that have been identified when no abnormal parathyroid tissue can be found. When four normal parathyroid glands are found in the neck, the fifth (abnormal) parathyroid gland is usually in the mediastinum. The surgeon’s responsibility is to make sure during parathyroidectomy that the elusive parathyroid adenoma is not in or removable through the cervical incision used for the initial operation and to minimize complications. The risk of permanent hypoparathyroidism or injury to the recurrent nerve should be less than 2%.

**Step 6: Closure**

Closure is essentially the same for parathyroidectomy as for thyroidectomy.

**COMPLICATIONS**

The complications of parathyroidectomy are similar to those of thyroidectomy but occur less often. Patients with a very high serum alkaline phosphatase level and osteitis fibrosa cystica are prone to profound hypocalcemia after parathyroidectomy. In such patients, both serum calcium and serum phosphorus levels are low. In contrast, patients with hypoparathyroidism exhibit low serum calcium levels but high serum phosphorus levels.

**OUTCOME EVALUATION**

Outcome considerations are essentially the same as for thyroidectomy. The patient should have a normal voice and be normocalcemic. The overall complication rate should be less than 2%.

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**Acknowledgment**

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