Radioguided Parathyroidectomy

1

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1.1 Introduction

Surgery is the only curative treatment for primary hyperparathyroidism. Several intraoperative adjuncts have been developed to facilitate parathyroidectomy to achieve a successful outcome. These include sestamibi-SPECT scanning, cervical ultrasound, 4D-CT scans, and intraoperative parathyroid hormone monitoring. One technology often overlooked is radioguided parathyroidectomy.

Radioguided parathyroidectomy is closely related to other radioguided techniques already in use for breast cancer, malignant melanoma, thyroid cancer, and colon cancer. A radiotracer is administered, which accumulates preferentially in the targeted tissue. Radioguided techniques localize specific tissue through the use of radioactivity, theoretically minimizing dissection and decreasing overall operative time.

The radiotracer utilized for radioguided parathyroidectomy is technetium ^{99m}Tc–sestamibi, which is the same compound used for preoperative parathyroid imaging. Its use is based upon the principle that enlarged, hypercellular parathyroid glands contain an increased number of mitochondria, and these mitochondria take up and retain ^{99m}Tc–sestamibi longer than surrounding tissues. Thus, the abnormal parathyroid becomes "hot" relative to surrounding structures. A hand-held gamma probe can then be utilized to detect the enlarged parathyroid gland. Once resected, the parathyroid gland can be assessed ex vivo for its radioguided counts. The counts are then used to determine if the gland is abnormal.

Radioguided parathyroidectomy has been shown to be effective in patients with primary, secondary, and tertiary hyperparathyroidism. It is not limited to patients who have positive sestamibi scans; it can also be used in those with negative scans. Thus, this technology is applicable to all patients undergoing surgery for hyperparathyroidism. The following sections discuss the details of the technique and its advantages.

1.2 Technique

About 1 hr prior to surgery, patients undergo an intravenous injection of 10 mCi ^{99m}Tc–sestamibi, one half the dose used for SPECT imaging (the effective time range can be from 20 min to 6 hr). We generally do not obtain any imaging on the day of surgery. Patients are then transported to the operating room for the procedure.

Once in the operating room, the patient is positioned in a beach chair orientation. At our institution, we routinely use general anesthesia with either an endotracheal tube or a laryngeal mask airway, but the procedure also can be performed under local anesthesia with monitored anesthesia care. Intraoperative parathyroid hormone (PTH) monitoring is utilized at our institution for virtually all parathyroidectomies. We draw a baseline PTH level after induction of anesthesia. The incision is generally 1.5–3.0 cm in length, and is made along a skin crease centered over the midline (Fig. 1.1). In cases of reoperative surgery, we try to use part of the old incision but occasionally may make a lateral incision along the anterior border of the sternocleidomastoid muscle for an upper parathyroid adenoma. Prior to incision, a background radioactivity count is performed. We obtain the background counts by placing the gamma probe over the thyroid isthmus (Fig. 1.2). However, other parathyroid surgeons prefer to obtain the background count over the left shoulder. We use an 11-mm collimated gamma probe (Neoprobe® 2000, Ethicon Endo-Surgery, Cincinnati, OH).

Once the background count has been obtained, the incision is made (Fig. 1.3). The subcutaneous tissues and platysma are divided horizontally without making skin flaps, and the strap muscles are divided vertically in the midline (Figs. 1.4 and 1.5). Many times, a preoperative localization scan will identify the location of the abnormal parathyroid

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gland and guide a focused approach. In those cases, the probe does not really add much more information about the location of the abnormal parathyroid. In cases of negative sestamibi scans, or if a bilateral exploration is planned, the gamma probe can be inserted through the incision to aid in identifying the location of abnormal parathyroid glands. The probe can be directed behind the thyroid gland to localize the parathyroid gland. Hypercellular parathyroid glands have in vivo radioactive counts higher than the background counts (Fig. 1.6). The probe in these cases can direct the area to dissect. After dissecting out the abnormal parathyroid gland, the vascular pedicle is clipped and divided (Fig. 1.7). The resected parathyroid gland is then placed on top of the gamma probe to obtain ex vivo counts (Fig. 1.8). Radioactive counts at least 20% of background have been shown to be consistent with hyperfunctioning parathyroid tissue, confirming successful resection of an abnormal gland. Lymph nodes, fat, and normal parathyroid tissue have been shown to have radioactive counts less than 20% of background.

We then sample for intraoperative parathyroid hormone (PTH) levels at 5, 10, and 15 min after resection of the parathyroid gland. If the PTH levels fall by more than 50%, the

Figure 1.1

Incision placement

Figure 1.2

The background radioactivity count level can be obtained by placing the gamma probe over the thyroid isthmus

operation is terminated. If the levels do not fall, further exploration is continued until other abnormal parathyroid glands are identified and resected. Once the operation is complete, the strap muscles are closed with a running 2-0 Vicryl suture. The wound is then injected with 20 mL 0.25% Marcaine (Fig. 1.9). The platysma is closed with a running 3-0 Vicryl suture. The skin is closed with a 5-0 Prolene subcuticular closure or skin glue (Fig. 1.10).

After surgery, patients are observed for a few hours in the same-day surgery unit. Nearly all patients are discharged home the same day as surgery. Ice packs are routinely used at our institution to minimize tissue swelling and aid in pain control. Oral analgesics are generally all that is needed to achieve adequate pain control. Patients are discharged home on oral TUMS® (GlaxoSmithKline) or other forms of calcium for 1 week to treat potential postoperative hypocalcemia due to bone hunger, and they are instructed to take additional doses for any symptoms of hypocalcemia (numbness, tingling, cramping). No labs are drawn until the postoperative visit 1 week later. Calcium and PTH levels are drawn at the 1-week and 6-month postoperative visits.

Figure 1.1

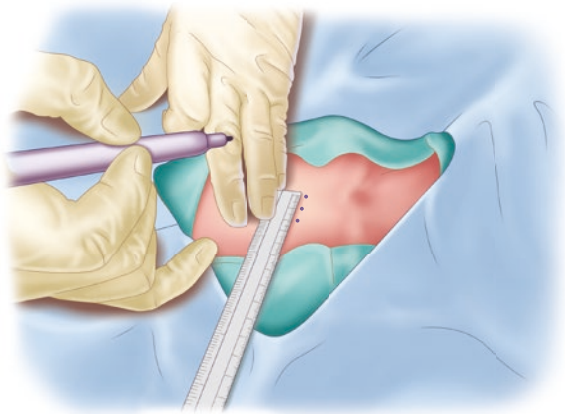


Figure 1.2

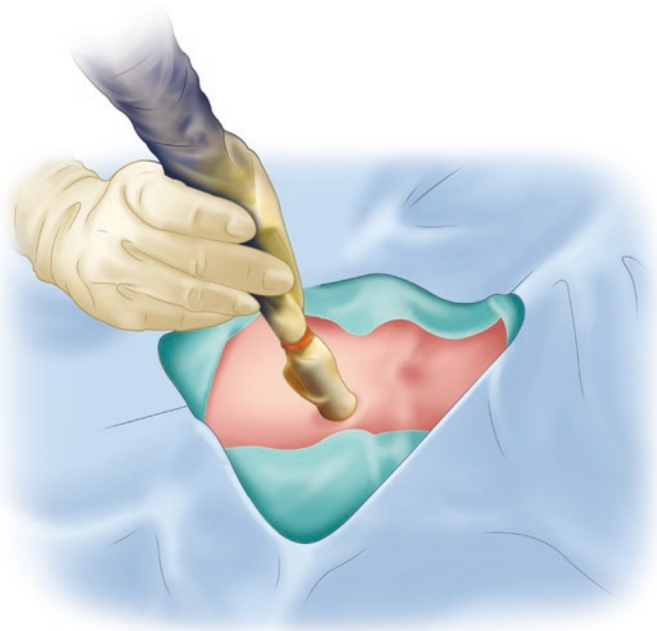


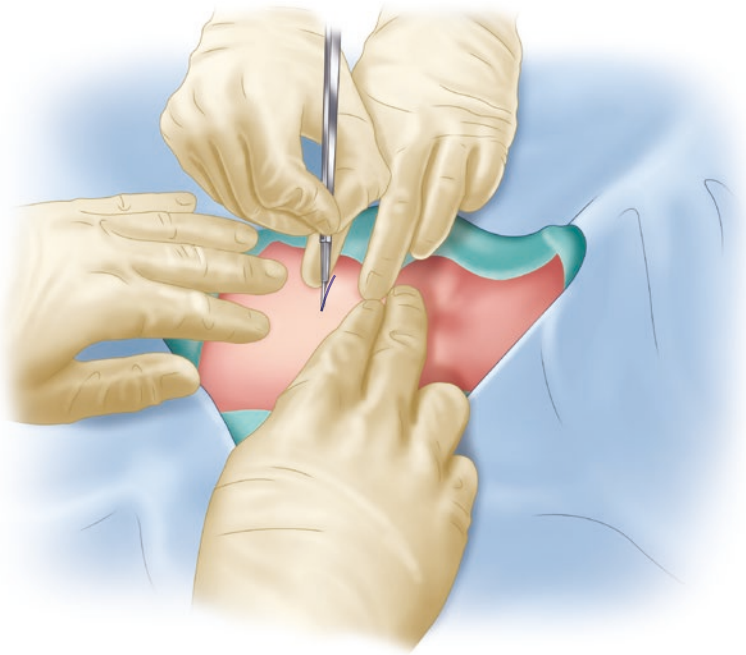
Figure 1.3

Making the incision

Figure 1.4

Dividing the platysma

Figure 1.3



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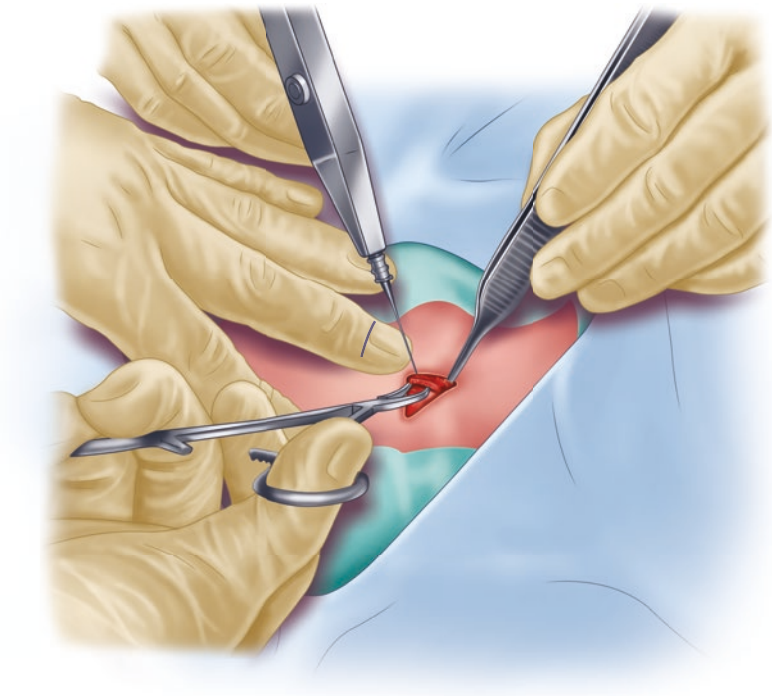


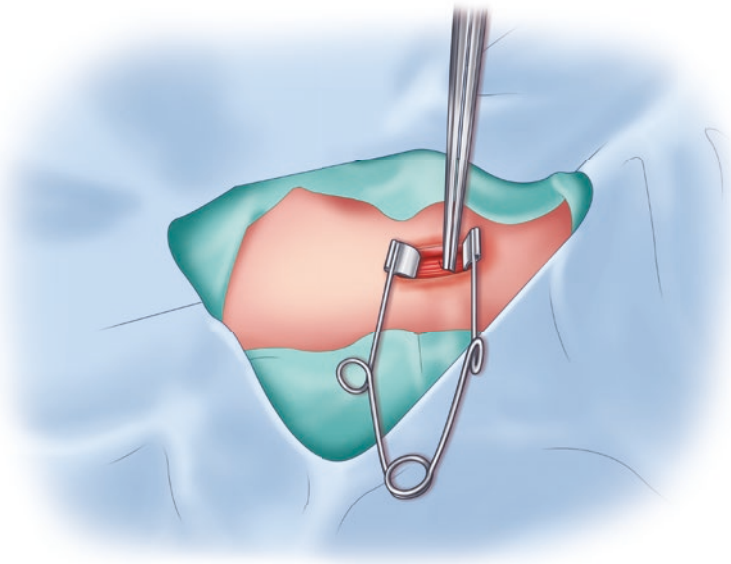
Figure 1.5

Dividing the strap muscles in the midline

Figure 1.6

Identifying the abnormal parathyroid gland with the gamma probe

Figure 1.5



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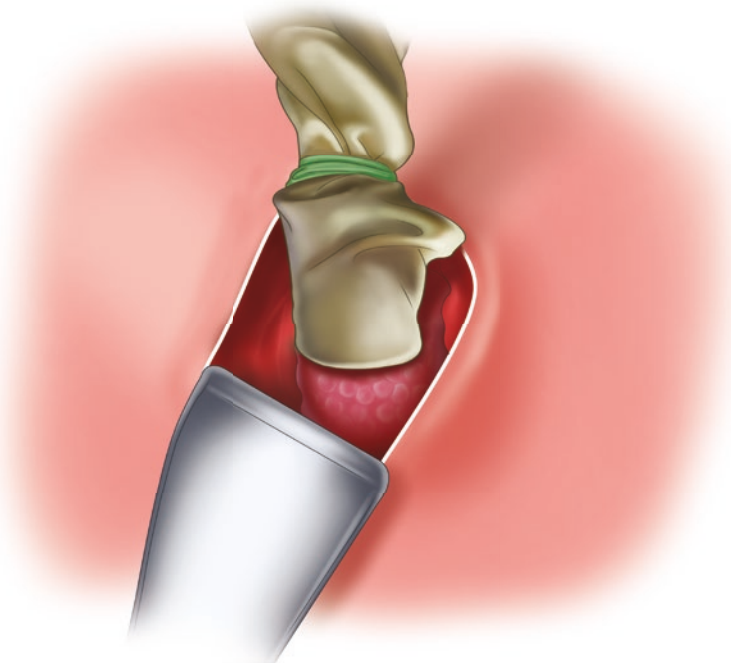


Figure 1.7

Isolating the vascular pedicle

Figure 1.8

Measuring ex vivo radioactive counts from the resected parathyroid gland

Figure 1.7

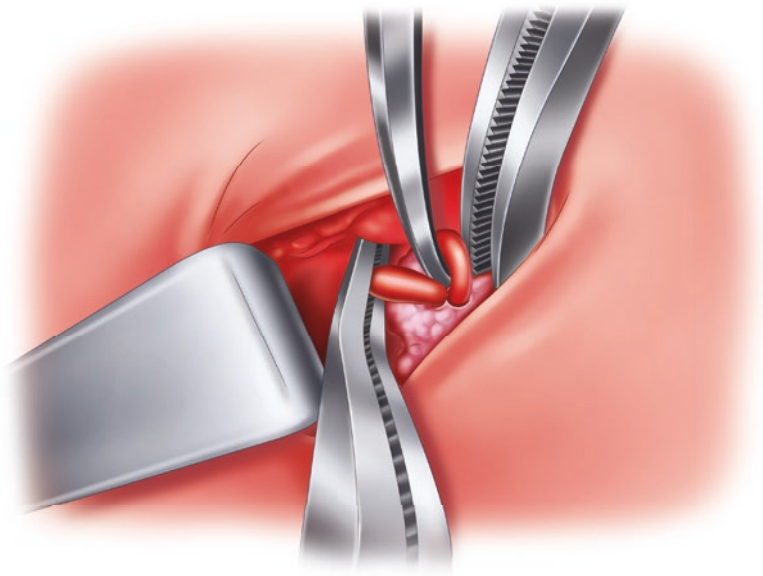


Figure 1.8

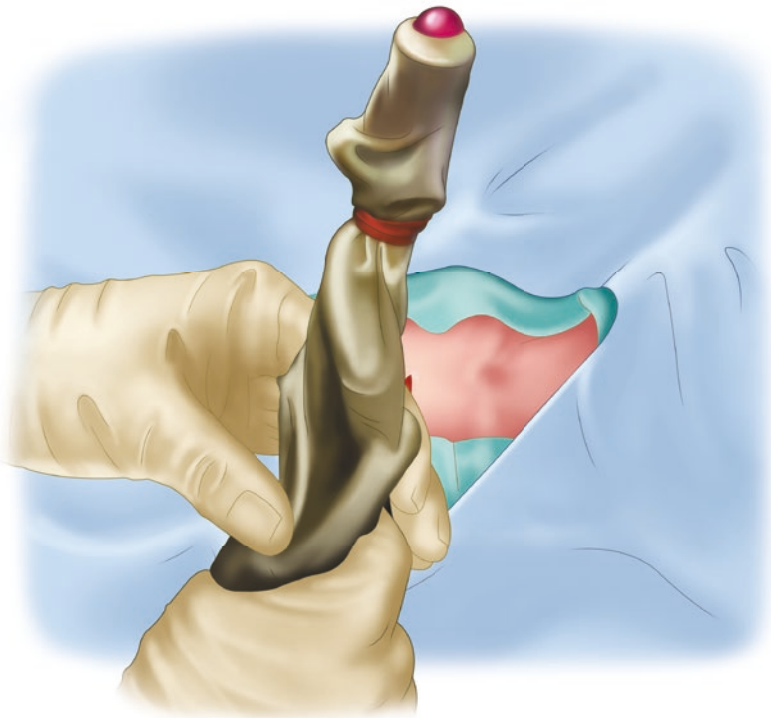


Figure 1.9

Injecting local anesthetic in the wound

Figure 1.10

Subcuticular closure

Figure 1.9

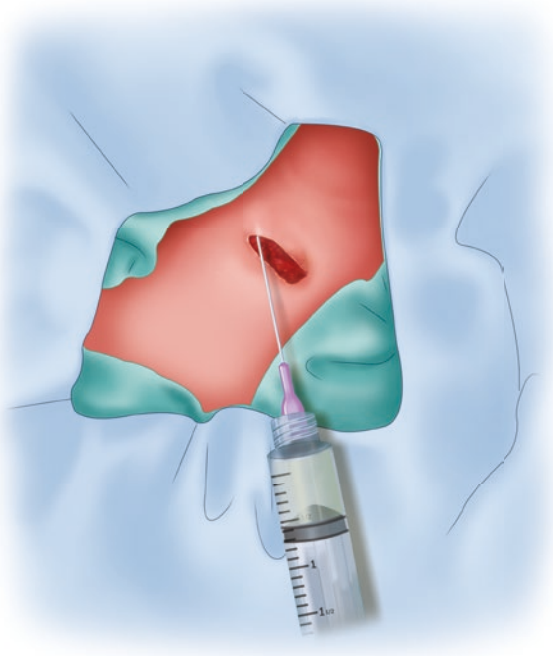
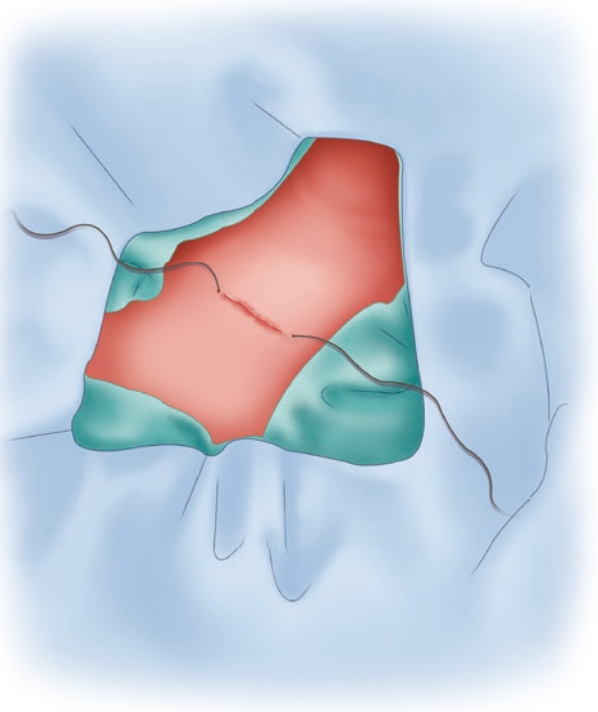


Figure 1.10



1.3 Discussion

Radioguided parathyroidectomy is another potential tool at the disposal of parathyroid surgeons. Because all hospitals often use the technology for sentinel node biopsies, radioguided parathyroidectomy is available to most surgeons. Although we use the Neoprobe® for our procedures, we have had experience with other hand-held probes, and all were sensitive for the detection of hypercellular parathyroids. We and others have previously shown that radioguided techniques are useful in patients with primary, secondary, or tertiary hyperparathyroidism. Furthermore, radioguided parathyroidectomy is effective in many special circumstances.

1.3.1 Sestamibi-Negative Patients

The gamma probe is able to detect high radioactive counts from all enlarged, hyperfunctioning parathyroid glands, including those that do not appear on imaging studies. Parathyroid localization studies such as sestamibi-SPECT, cervical ultrasound, and CT scans will fail to localize an abnormal parathyroid gland in up to 20% of patients with primary hyperparathyroidism. These glands tend to be smaller. Because the gamma probe can be positioned very close to the parathyroid, it can detect radioactive counts with great sensitivity. Abnormal parathyroid glands missed on imaging studies will still take up sestamibi at higher levels than surrounding tissue.

1.3.2 Ectopic Glands

The gamma probe can be helpful in localizing abnormal parathyroid glands in ectopic locations, such as intrathyroidal, undescended, and mediastinal glands. If a preoperative sestamibi scan shows a parathyroid adenoma down in the mediastinum, a video-assessed thoracoscopic approach with a laparoscopic gamma probe can be used.

1.3.3 Familial Primary Hyperparathyroidism

We have shown that radioguided parathyroidectomy is very effective in patients with familial primary hyperparathyroidism, parathyroid hyperplasia, or both. Though parathyroid adenomas tend to have ex vivo counts well over 20% of background, patients with parathyroid hyperplasia from primary hyperparathyroidism tend to have ex vivo counts between 20% and 40%.

1.3.4 Secondary and Tertiary Hyperparathyroidism

Patients with secondary or tertiary hyperparathyroidism most commonly have parathyroid hyperplasia. We do not routinely obtain preoperative imaging studies in these patients at their initial parathyroidectomy and perform bilateral exploration. We have shown that radioguided parathyroidectomy may reduce operative time in these patients. In patients with previous autotransplants, the gamma probe can localize the hyperplastic parathyroid tissue within the muscle body. To minimize confusing background levels, the sestamibi injection should be administered in the contralateral limb of these patients.

1.3.5 Pediatric Patients

Radioguided parathyroidectomy is safe and effective for children with hyperparathyroidism. The same dose of ^{99m}Tc–sestamibi can be administered.

1.3.6 Reoperative Surgery

Many surgeons believe that radioguided techniques do not provide much additional information for patients undergoing an initial operation for hyperparathyroidism, but most acknowledge that this technology has an important role in reoperative parathyroidectomy. During these potentially difficult operations, scar tissue can obscure landmarks, making identification of the abnormal parathyroid challenging. The gamma probe in these circumstances can facilitate intraoperative localization (through high in vivo radioactive counts) and can confirm successful resection of hyperfunctioning parathyroid tissue (by high ex vivo radioactive counts).

1.4 Summary

Radioguided parathyroidectomy is an underappreciated technique for the management of patients with primary, secondary, or tertiary hyperparathyroidism. It should be considered as part of the surgical armamentarium for patients undergoing parathyroidectomy.

Suggested Reading

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