Preoperative Localization of Recurrence in the Thyroidectomy Bed Using a Radioactive Iodine $^{125}$ Seed

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Abstract

Intraoperative localization of nonpalpable recurrent thyroid cancer has been reported using needle localization, intraoperative ultrasound (US), dye injection, and radio-guided surgery. We describe the alternative technique of radioactive seed localization (RSL) in 3 patients with residual or recurrent papillary thyroid cancer. This technique has been used for many years in the setting of nonpalpable breast cancer, where it has been shown to be safe and has been associated with greater surgeon satisfaction as well as improved patient tolerability, cosmesis, and outcomes compared to needle localization. In addition, RSL allows complete decoupling of the radiology and surgery schedules. RSL was successful in our 3 patients with regard to safety, patient tolerability, and scheduling.

Keywords
thyroid, recurrence, radioactive, seed, localization

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Thyroid cancer treatment has progressively improved over the past 2 decades, which is in part due to advancements in preoperative planning as well as surgical techniques. Despite improved care, persistent disease and local recurrence occur in patients categorized as low risk and intermediate risk based on surgical and pathological findings.

The standard of care for palpable recurrence in cervical lymph nodes is a neck dissection, but there is no widely accepted standard treatment for nonpalpable recurrence in the neck, which can include repeat surgery, iodine$^{131}$ radioablation, and/or observation. There are several risks involved with reoperation, including nerve injury, hypoparathyroidism, prolonged operative times due to scarring, and inability to find and resect the recurrence.$^1$

The safety and efficacy of preoperative ultrasound (US)–guided needle localization as an aid for intraoperative identification of recurrent thyroid cancer has been reported in the literature.$^1$ This technique has been widely used for nonpalpable breast lesions for many years, but at our institution, we have been successfully employing radioactive seed localization (RSL) in place of needle localization since 2004. RSL has had enduring positive impacts on our scheduling and patient and physician satisfaction. We recently broadened the use of RSL to nonpalpable masses of the soft tissues, including sarcoma, melanoma, lymphoma, and metastases, as well parathyroid adenoma.$^2$ In this clinical technique report, we describe our experience with RSL in patients with residual and recurrent papillary thyroid cancer using a radioactive iodine$^{125}$ ($^{125}$I) seed implanted under US guidance.

Methods

The Mayo Clinic Institutional Review Board has approved implantation of an $^{125}$I seed for preoperative RSL in the nonbreast soft tissues, including thyroidectomy beds. Informed consent was obtained. Of note, the $^{125}$I seeds used in RSL are only for localization and not for treatment of thyroid cancer.

From April 2017 to the present, patients with biopsy-proven nonpalpable residual or recurrent papillary thyroid cancer were offered ultrasound-guided RSL with an $^{125}$I seed. The seeds have a nominal activity of 0.15 millicurie (mCi) and a shelf life of 90 days. Real-time sonography was used to observe the advancement of the delivery needle into the cancer recurrence (Figure 1). The radioactive seed was deployed within the abnormal tissue (Figure 2) with a mandrel pusher, and the delivery needle was then removed. A postprocedure radiograph of the lower neck was performed to confirm placement in the desired location (Figure 3). An interventional radiologist with 24 years of postfellowship experience performed the seed localizations.

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The standard US Nuclear Regulatory Commission guidelines state that seeds remain implanted 5 days or less prior to surgery. The patients underwent surgery by the same otolaryngology surgeon with 4 years of postfellowship experience. Intraoperatively, the surgeon applied a sterilized gamma probe over the expected region of the recurrence, where a radioactivity count value was provided on a wireless monitor display to help determine the specific site of highest radioactivity and plan the skin incision. After removal, the surgeon used the gamma probe to verify activity in the specimen and no activity in the operative bed. Each specimen was transported to the pathology laboratory for frozen-section analysis of the inked margins. A NaI detector was used to isolate the exact location of the seed within each inked specimen, which was retrieved and transferred to nuclear medicine. Following retrieval of the seed from the specimen, the specimen was frozen and sectioned.

Results

Three patients with locally recurrent or residual papillary thyroid cancer underwent RSL with a single 125I seed implanted directly into the target tissue under real-time US guidance. Demographic, clinical, and operative data for the 3 patients are summarized in Table 1. The patient with an operative time of 109 minutes underwent right neck reexploration following the frozen-section analysis of the tissue containing the seed. The residual tumor was densely adherent to the tracheal wall and recurrent laryngeal nerve, precluding R0 resection without tracheal reconstruction. The patient had preoperatively declined tracheal reconstruction; therefore, she was referred for external beam and radioiodine therapy. The other 2 patients had negative margins. There was no seed migration in any patient.

Discussion

There is no standard for preoperative localization of non-palpable extra-mammary soft tissue masses, including residual or recurrent thyroid cancer. Localization methods such as needle localization, intraoperative US, intraoperative dye injection, and radio-guided surgery have been described for residual and/or recurrent thyroid cancer in the literature. Due to our 13-year experience with RSL in the breast and 4-year experience with RSL in soft tissues beyond the breast, we began to offer RSL to patients with...
residual or locally recurrent thyroid cancer. There are no specific exclusion criteria for the use of I\textsuperscript{125} seeds in individual patients.

Our goals for RSL are to provide a well-tolerated procedure that improves patient and surgeon satisfaction by decoupling the radiology and surgery schedules, improving cosmesis with shorter skin incisions and smaller resected tissue volumes, and enhancing surgeon confidence in the identification and resection of small residual/recurrent disease measuring <1.5 cm. This, in turn, could potentially decrease operative times.

For our 3 patients, the RSL was scheduled on the same day as the mandatory preoperative evaluation or the morning of surgery to maximize patient convenience. The 5-day window between seed placement and surgical retrieval has optimized flexibility in scheduling. RSL was well tolerated by the 3 patients as indicated by the VAS scores.

There are a few precautions in regard to handling the seed, the most important of which is awareness of the location of the seed at all times. For these purposes, the surgeon uses a gamma probe, and the radiology and pathology teams use a NaI detector as described in the Methods. Other precautions include not touching the seed directly and not using suction intraoperatively to prevent inadvertent loss of the seed.

There are disadvantages to RSL, primarily the regulatory requirements from a state’s Bureau of Radiation Control. These requirements are ideally managed by an institution’s radiation safety officer. Radiation exposure to the 3 patients and the medical personnel involved in their care was not recorded. Of note, exposure for more than 24 hours to the patient with an I\textsuperscript{125} seed in the breast has been found to be equivalent to 2 chest radiographs. Exposure to health staff has been reported as negligible.\textsuperscript{7}

In conclusion, RSL has been performed in 3 patients with residual and recurrent papillary thyroid cancer with no complications related to the localization procedure or the operation itself. The procedure was well tolerated by the 3 patients and is favored by our surgeon for nonpalpable disease compared to no localization or wire localization.

**Author Contributions**

Hillary W. Garner, primary contributor to the conception, analysis, and interpretation of the work, primary drafter of the work; Ricardo Paz-Fumagalli, contributor to the conception, analysis, and interpretation of the work, revised the manuscript; Geoffrey D. Young, contributor to the conception, analysis, and interpretation of the work, revised the manuscript.

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**References**

1. Eng OS, Grant SB, Weissler J, Simon M, Roychowdhury S, Davidov T, Trooskin SZ. Operative bed recurrence of thyroid...
cancer: utility of a preoperative needle localization technique. 


