I-123 Thyroid Scintigraphy

Primary Indications: Thyroid scintigraphy with I-123 is indicated to evaluate thyroid morphology and global and/or regional function for purposes of: (1) detecting ectopic thyroid tissue, particularly substernal extension of a multinodular goiter (when the results of CT are not definitive) or true ectopic mediastinal thyroid tissue; (2) determining if a thyroid nodule in a hyperthyroid patient is a toxic nodule; and (3) determining whether a functioning thyroid nodule seen on Tc-99m pertechnetate scintigraphy is truly functioning or one with so-called "discordant" function. The use of thyroid scintigraphy to evaluate the function of a thyroid nodule in order to assess its likelihood of malignancy has largely been supplanted by fine-needle aspiration biopsy (FNA). I-123 thyroid scintigraphy is rarely performed to assess nodular function in a euthyroid patient, when FNA yields indeterminate results i.e., follicular neoplasm.

If I-131 treatment is anticipated in a hyperthyroid patient who may have a toxic thyroid nodule, an I-123 thyroid uptake should be performed in addition to thyroid scintigraphy. Generally, hypofunctioning nodule(s) in a hyperthyroid patient should be biopsied to confirm that the nodule is benign prior to treatment with I-131.

Rationale: Iodine, as iodide ion, is normally accumulated within thyroid follicular cells by an active transport mechanism (trapping) and is then oxidized and bound to tyrosyl residues on thyroglobulin (organification); these are the initial steps in the synthesis of thyroid hormones. Radionuclides of iodine are handled in identical fashion, and this allows for the scinti-graphic assessment of thyroid tissue.

The thyroid tissue/background uptake ratio achievable with radioiodine is much higher than that achievable with Tc-99m pertechnetate, because the latter is trapped but not organified. As blood levels of Tc-99m per-technetate decrease with time after injection, the thyroidal tracer uptake also declines. By comparison, the organified fraction of radioiodine remains in the thyroid gland as blood levels fall. Hence, detection of thyroid tissue in regions with high blood-pool activity, such as the mediastinum, is easier on delayed radioiodine images than on Tc-99m per-technetate images.

Some thyroid nodules (both benign and malignant) retain the trapping function, but do not organify significant amounts of iodine. Thus, such nodules appear to be functioning (generally taken as an indicator of benignancy) on Tc-99m pertechnetate images, when they are, in fact, hypofunctioning on radioiodine images (generally taken as indicator of malignancy).

Follicular adenoma and follicular carcinoma generally cannot be distin-guished cytologically. If thyroid scintigraphy is requested to help make this distinction (based on the principle that a functioning nodule is likely to be an adenoma), the study should be
performed with I-123 in order to avoid the problem with discordant nodular function discussed above.

Except for detection of functioning thyroid carcinoma, I-123 is preferred to I-131 for thyroid imaging because of the lower thyroidal radiation dose and better imaging properties of I-123.

**Interfering Conditions:** Antithyroid-drug (propylthiouracil or methimazole) therapy within 3 days of the test; thyroid hormone therapy; and recent administration of iodinated contrast agents or other iodine-containing drugs will lower the thyroidal uptake of radioactive iodine.

**Contraindications:** I-123 administration is relatively contraindicated in pregnant women because of the radiation dose to the fetal thyroid gland (which begins to accumulate radioiodine at 8-10 weeks gestational age). Accordingly, it should be documented that a patient who could potentially bear children is not pregnant before the administration of I-123 by establishing that the patient is premenarchal or postmenopausal; has had tubal ligation or hysterectomy; or has had a negative serum (or urine) qualitative beta-HCG within the previous 3 days (and preferably within 1 day of treatment, i.e., typically on the day that the thyroid uptake measurement is started). In rare circumstances, documentation of non-pregnancy by careful clinical history will be sufficient if so judged by the responsible attending nuclear medicine physician.

I-123 administration is contraindicated in women who are breast feeding because a large fraction of the administered activity will be secreted in breast milk, which when ingested will cause radiation exposure to the infant’s thyroid gland. Additionally, I-123 administration should be delayed for 4-6 weeks postpartum or after cessation of breast feeding to allow breast tissue to return to a basal state in order to minimize the dose to the patient’s breasts.

**Radiopharmaceutical:** I-123 sodium iodide capsule

**Adult Dosage:** 200-400 µCi

**Pediatric Dosage:** 3-6 µCi/kg with a minimum dosage of 100 µCi (the smallest available capsules are 100 µCi)

**Radiation Dosimetry:** Adult. (400 µCi dosage with a normal thyroid uptake value of 15%). Critical organ (thyroid): 2.81 rem. Effective dose: 0.11 rem.

Infant (1 year). (100 µCi dosage with a normal thyroid uptake value of 15%). Critical organ (thyroid): 7.00 rem. Effective dose: 0.23 rem.

**Route of Administration:** Oral
Patient Scheduling: For patients referred for thyroid uptake measurement and possible treat-ment, requests should be submitted by the referring physician using the “Physician Request Form for Radioiodine Uptake and/or Treatment” (attached), which must be approved by a nuclear medicine attending physician. If that form indicates that thyroid scintigraphy is necessary in addition to thyroid uptake measurement, this should be performed with I-123 in accordance with this procedure. The radiopharmacy staff should be notified that the study is scheduled and that I-123 needs to be ordered.

Other requests for thyroid scintigraphy Requests for thyroid scintigraphy may be submitted by the referring physician using the “Physician Request Form for Thyroid Imaging” (attached), which must be approved by a nuclear medicine attending physician before the study is scheduled. This is necessary to assess the indication for the study, to document that there are no interfering conditions/medications, and to determine whether the study is to be performed with Tc-99m pertechnetate or I-123. As an alternative, a telephone scheduling request for Thyroid Scintigraphy should be directed to a staff or resident physician, who should obtain all the required scheduling information, enter it on the “Physician Request Form for Thyroid Imaging”, and then notify a nuclear medicine registrar to schedule the study.

Patient Preparation: None

Uptake Equipment Setup: Capintec Thyroid Uptake Probe

Imaging Equipment Setup: Gamma Camera: LFOV or SFOV
Collimator: Pinhole and, if needed for mediastinal imaging, low-energy, high-resolution parallel-hole collimator
Energy Window: 159 keV with 20% window

Patient Positioning: Sitting erect for uptake measurement. Supine for scintigraphy.

Uptake Procedure: Counting the Standard (Day 1)

1. Before dispensing the I-123 capsule, the technologist should recon-firm that the patient has not received interfering medications (e.g., antithyroid drugs, thyroid hormone, contrast agents) or other radio-pharmaceuticals (especially previous administration of I-131). The latter should be checked by performing a survey count of the patient’s neck with a Geiger-Mueller (G-M) meter kept in the radio-pharmacy. This is done as follows.

   a. In the dose administration room, first observe the background dose rate of the G-M meter for approximately 20 seconds and record the average value during the last 10 seconds.
b. If average background exceeds 0.05 mR/hour, move to another room and repeat background measurement. Then place probe against the patient’s thyroid region for approximately 20 seconds and record the average value during the last 10 seconds.

c. If the patient’s neck reading is more than 0.05 mR/hour, it should be assumed that the patient has previously received another radiopharmaceutical. The patient should be carefully questioned to determine the nature of the other radiopharmaceutical, and a "residual" count of the patient's neck must be obtained before giving the uptake dosage. It may also be necessary to increase the administered dosage of I-123 for the uptake measurement (per physician direction). The following information is recorded on the Endocrine System “Nuclear Medicine Medication Verification Form”:

   i. Background G-M count-rate
   ii. Patient G-M count-rate
   iii. Technologist’s initials. ______

2. Place the capsule into the neck phantom for a standard count (the capsule holder insert is in the Radiopharmacy source drawer)

3. At the uptake probe input screen Press the Home Key 4. Press the UTIL key

5. Press 1 for Multichannel Analyzer

6. Press 2 for Probe

7. Press 3 for Choose Setup

8. Press Enter in Setup

9. Press 1 to Measure Source. Display should show:
   a. Scale: 200 keV
   b. Counting Time: 300 sec.
   c. Counting Time Base: Live

10. Continue with F4

11. Continue with F4

12. Background not counted yet…? Answer: N (for No) and Enter

13. Start Measure

14. After Counting has stopped, Press F3 for ROI

15. Move cursor to 143 keV by using the arrow keys. Press Enter

16. Move cursor to 178 keV by using the arrow keys. Press Enter

17. Print 2 copies of the “Standard” Capintec computer sheet in case one gets misplaced.

Counting the Patient (Day 2)
1. Perform the **background** and the **patient uptake** neck count on day 2 using the same parameters listed above for counting the standard. Label the printouts with
   a. Patient name
   b. Date of birth
   c. Date of study
2. Enter the data into the thyroid uptake spreadsheet.
3. A complete study to be turned in to the physicians includes:
   a. A printed copy of the thyroid uptake spreadsheet
   b. Standard Count uptake probe printout
   c. Background Count uptake probe printout
   d. Patient count uptake probe printout

**Imaging Procedure**

Perform imaging 18-24 hours after administration of I-123. Obtain ante-rior and both right and left 20-30° anterior oblique views of the neck with the pinhole centered over the thyroid region at a pinhole aperture-to-neck distance of 4.0 cm for 100K counts or 10 minutes, whichever requires less time.

Ask physician to check images in order to determine if additional views are needed. If requested, an anterior image of the neck and mediastinum should be obtained with a parallel-hole collimator for 200K counts or 10 minutes, whichever requires less time. If images are obtained with a point-source or lead marker placed by physician over a palpable nodule, the pinhole aperture should always be centered over the marker, to pre-vent parallax error.

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<td>Anterior pinhole (4 cm)</td>
<td>100K counts or 10 min, which-ever requires less time</td>
<td>256 x 256 matrix, word mode</td>
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<tr>
<td>Oblique pinhole images (4 cm)</td>
<td>100K counts or 10 min, which-ever requires less time</td>
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<tr>
<td>Anterior neck/mediastinum</td>
<td>200K counts or 10 min, which-ever requires less time</td>
<td>256 x 256 matrix, word mode</td>
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**Items Required For Complete Study:**

1. Pinhole image at 4 cm pinhole-to-neck distance
2. Additional views, as requested by physician
3. I-123 uptake if indicated with completed thyroid uptake spreadsheet.

4. Transfer of all digital images to archival computer.