Society of Nuclear Medicine Procedure Guideline for Extended Scintigraphy for Differentiated Thyroid Cancer

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I. Purpose

The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting, and reporting the results of extended scintigraphy for differentiated thyroid cancer.

II. Background Information and Definitions

Scintigraphy for detection of thyroid metastasis and/or residual functioning thyroid tissue consists of obtaining images of the body, 2–6 days following the oral ingestion of I-131. Other radiopharmaceuticals such as I-123, Tl-201 and Tc-99m sestamibi may also provide useful information.

III. Common Indications

To determine the presence and extent of residual functioning thyroid tissue and the presence and location of functioning thyroid cancer.

IV. Procedure

The patient should be seen by the nuclear medicine physician sufficiently early to assure the appropriate diagnosis has been made, patient suitability for scintigraphy, the necessary laboratory studies have been obtained, and low-iodine diet instructions have been given. This initial appointment is important for establishing the doctor/patient relationship.

A. Patient Preparation

1. Avoidance of Interfering Materials
   The concentration of radioiodine in the thyroid is affected by many factors such as:
   a. Medications, such as thyroid hormones and antithyroid agents which affect the pituitary-thyroid axis
   b. Iodine-containing food (e.g. kelp) and medications (e.g. iodinated contrast, amiodarone, betadine)

   Imaging should be delayed for a period long enough to eliminate the effects of these interfering factors. A low iodine diet is sometimes followed for 3–10 days before the radioiodine is given, as it can significantly increase the uptake of radioiodine.
2. Maximum sensitivity of whole-body scintigraphy for detection of functioning metastases can only be achieved in the absence of significant residual functioning thyroid tissue, since it requires a TSH level of 30 μU/ml or more. This level of TSH can be reached by waiting 4–6 wk or more after thyroidectomy or after stopping treatment with thyroxine (T4). In order to avoid prolonged hypothyroidism, patients may be maintained on triiodothyronine (T3) until 2 wk prior to administration of the radioiodine.
3. Serum TSH level should be measured immediately prior to the time of the radioiodine administration. Ideally, the TSH levels should be greater than 30 μU/ml unless there is significant residual functioning thyroid tissue.
4. The sensitivity of whole-body scintigraphy can be further improved if the patient follows a strict low-iodine diet starting 3–10 days prior to administration of the radioiodine tracer and continuing throughout the period of imaging (and treatment).
5. Since iodine is excreted primarily in the urine and secondarily in the gastrointestinal tract, a mild laxative is sometimes given on the

evening before imaging to decrease the amount of activity within the colon, thereby decreasing the radiation dose to the colon and simplifying image interpretation.

B. Information Pertinent to Performing the Procedure
   1. Patient's compliance with a low-iodine diet
   2. TSH level
   3. History of thyroid hormone withdrawal
   4. Measurement of serum thyroglobulin levels
   5. Description of operative procedure (extent of thyroidectomy) and gross microscopic findings
   6. Tumor pathology, including presence or absence of capsular and/or blood vessel invasion and lymph node involvement
   7. Results of other imaging procedures
   8. Physical findings
   9. History of prior I-131 treatment
   10. Results of prior radioiodine extended scintigraphy
   11. History of prior administration of contrast or iodine-containing drugs (e.g. amiodarone)
   12. Menstrual history/pregnancy test
   13. Nursing/Lactation history

C. Precautions
   Patients receiving more than 2 mCi of I-131 should follow the same precautions as patients treated with I-131 for hyperthyroidism.

D. Radiopharmaceutical
   1. Oral I-131 is generally preferred. Administered amounts of 5 mCi or less are preferred due to the possibility of stunning (decreased uptake by residual functioning thyroid tissue or tumor of the activity administered for treatment due to dysfunction caused by the activity administered for diagnosis).
   2. Oral I-123 may be used in administered amounts of 1–2 mCi, although experience with this tracer is limited.
   3. Thallous chloride i.v. or Tc-99m sestamibi i.v. have been used in conjunction with I-131 in some circumstances, particularly for nonfunctioning metastases.

      Potential advantages: (a) no patient preparation is required (i.e. thyroid hormone does not need to be withdrawn); (b) accumulates in most of the 25% of differentiated thyroid cancers that do not concentrate radioiodine and in some thyroid cancers that rarely concentrate radioiodine (e.g. Hurthle cell and medullary carcinomas); and (c) may demonstrate metastases when TSH is normal or suppressed.

      Disadvantages: (a) does not provide information needed for subsequent I-131 treatment about the avidity of the tumor for radioiodine; and (b) may not be as sensitive as I-131 for detection of metastases of functioning well differentiated thyroid cancer.
   4. Radiation Dosimetry (see Table)

E. Image Acquisition
   1. Instrumentation
      For I-131, large field of view camera or rectilinear scanner and a high energy collimator. For I-123, Tl-201 and Tc-99m, a low-energy collimator and a large field of view camera are preferred.
   2. Patient positioning
      Lying supine on an imaging table
   3. Timing of the Images
      a. For I-131, images are obtained 48–72 hr after the radiopharmaceutical administration. Later images, when background is diminished, often provide better definition of low-activity lesions. Imaging 1–2 wk after a therapeutic dose of I-131 can be helpful in demonstrating poorly-functioning metastasis.
      b. For I-123, images are obtained 24 hr following the administration of the radiopharmaceutical.
      c. For Tl-201 and Tc-99m sestamibi, images are obtained 15 min after administration of the radiopharmaceutical.
   4. Image Acquisition
      a. Anterior and posterior images of most of the body are obtained. Spot images should be obtained for approximately 5–10 min per view. Longer imaging times may be helpful for images obtained more than 3 days after administration of the radioiodine.
      b. If images are obtained with a whole-body scanner, the scan speed should be adjusted so that whole body imaging takes approximately 30 min per view.
      c. Pinhole and/or rectilinear images of the neck in combination with adequate anatomic markers and careful palpation are useful in differentiating between normal residual thyroid tissue, salivary gland uptake, residual thyroid cancer, and lymph node metastasis.

F. Interventions
   Giving the patient water to drink is sometimes useful to eliminate mouth and esophageal activity.

G. Processing
   None

Radiation Dosimetry in Adults

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose* mSv (rem)
Na-I-123 iodide[1]	37 – 74 p.o. (1 – 2)	0.09 Bladder Wall (0.33)	0.013 (0.048)
Na-I-131 iodide[2]	74 – 370 p.o. (2 – 10)	0.61 Bladder Wall (2.3)	0.072 (0.27)
T1-201 chloride[3]	110 – 185 i.v. (3 – 5)	0.54 Kidney (2.0)	0.23 (0.85)
Tc-99m sestamibi[4]	370 – 740 i.v. (10 – 20)	0.039 Gallbladder Wall (0.14)	0.0085 (0.031)

[1]ICRP 53, page 263, 0% uptake
[2]ICRP 53, page 275, 0% uptake
[3]ICRP 53, page 373
[4]ICRP 62, page 23, resting
*Per MBq (per mCi)

H. Interpretation Criteria

An adequate physical examination and history should be obtained. The presence of palpable tissue in the neck should be defined for correlation with the scintigraphic findings.

Special attention should be paid to the precise placement of markers on anatomical landmarks. For appropriate interpretation of anterior thyroid bed findings, it is necessary to be certain of the location of the nose and / or mouth, thyroid cartilage and sternal notch in the neck. For whole-body imaging, other landmarks may be important such as costal margins, xyphoid process, pubic symphysis, and iliac crests. Posteriorly, the location of the spine, iliac crests, etc. should be identified and transferred to the film. In addition to the scintigraphic images on which the markers have been transferred, duplicate images should be obtained without the markers, which may interfere with interpretation of areas of borderline uptake. Right and left differentiation and anterior and posterior differentiation should, of course, be noted.

I. Reporting

The report should include the size, activity and location of any areas of uptake that correspond to any functioning normal or abnormal thyroid tissue. Particular attention should be paid to activity in the thyroid bed. Scan images cannot differentiate residual normal thyroid tissue (i.e. thyroid remnants) from tumors or abnormal foci of activity. Comparison with prior scans can often be useful in defining the significance of localized neck activity. Lateral and oblique views may be useful in separating thyroid bed activity from neighboring lymph node activity.

Results of recent thyroglobulin assays are useful in interpreting the scintigraphic finding.

J. Quality Control

See *Society of Nuclear Medicine Guideline on General Imaging*.

K. Sources of Error

1. Local contamination (clothing, skin, hair, collimator, crystal)
2. Esophageal activity
3. Asymmetric salivary gland uptake
4. Nonspecific uptake in pulmonary infections
5. Breast uptake in a lactating female
6. Thymus uptake

V. Issues Requiring Further Clarification

A. What is the best dose of I-131 for whole-body imaging that would provide the most diagnostic

information and would avoid stunning (see section IV.D.1. above).

B. The role of I-123 in whole-body surveys for metastatic disease should be considered, particularly considering the decreased stunning and radiation exposure associated with this isotope. The increased cost of a whole-body scanning dose of this isotope must also be considered.

C. Lithium administration may promote retention of radioiodine in metastatic foci.

VI. Concise Bibliography

Brucker-Davis F, Reynolds JC, Skarulis MC, et al. False-positive Iodine-131 whole body scans due to cholecystitis and subaceous cyst. *J Nucl Med* 1996;37:1690.

Lakshmanan M, Schaffer A, Robbins J, et al. A simplified low-iodine diet in I-131 scanning and therapy of thyroid cancer. *Clin Nucl Med* 1988; 13:866–868.

Maxon HR, Thomas SR, Boehringer A, et al. Low-iodine diet in I-131 ablation of thyroid remnants. *Clin Nucl Med* 1983;8:123–126.

Maxon HR, Thomas SR, Hertzberg VS, et al. Relation between effective radiation dose and outcome of radioiodine therapy of thyroid cancer. *N Engl J Med* 1983;309:937–941.

Park HM, Park YH, Zhou XH. Detection of thyroid remnant / metastases without stunning: an ongoing dilemma. *Thyroid* 1997;7(2):277–280.

Ramanna L, Waxman AD, Braunstein G. Thallium-201 scintigraphy in differentiated thyroid cancer: comparison with radioiodine scintigraphy and serum thyroglobulin determinations. *J Nucl Med* 1991;32:441–446.

Sherman SI, Tielens ET, Sostre S, et al. Clinical utility of post-treatment radioiodine scans in the management of patients with thyroid carcinoma. *J Clin Endocrinol Metab* 1994;78:629–634.

Sisson JC. Selection of the optimal scanning agent for thyroid cancer. *Thyroid* 1997;7(2):295–302.

Yen TC, Lin HD, Lee CH, et al. The role of technetium-99m-sestamibi whole-body scans in diagnosing metastatic Hurthle cell carcinoma of the thyroid gland after total thyroidectomy: a comparison with iodine-131 and thallium-201 whole-body scans. *Eur J Nucl Med* 1994;21:980–983.

VIII. Disclaimer

The Society of Nuclear Medicine has written and approved guidelines to promote the cost-effective use of high quality nuclear medicine procedures. These generic recommendations cannot be applied to all patients in all practice settings. The guidelines should not be deemed inclusive of all proper procedures or exclusive of other procedures reasonably directed to obtaining the same results. The spectrum of patients seen in a specialized practice setting may be quite different than the spectrum of patients seen in a more general practice setting. The appropriateness of a procedure will depend in part on the prevalence of disease in the patient population. In addition, the resources available to care for patients may vary greatly from one medical facility to another. For these reasons, guidelines cannot be rigidly applied.

Advances in medicine occur at a rapid rate. The date of a guideline should always be considered in determining its current applicability.