

Society of Nuclear Medicine Procedure Guideline for Thyroid Scintigraphy

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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 thyroid scintigraphy.

II. Background Information and Definitions

Thyroid scintigraphy is a procedure producing one or more planar images of the thyroid obtained within 15–30 min after intravenous injection of Tc-99m pertechnetate or 3–24 hr after the oral administration of I-123 or I-131 sodium iodide.

In this document, hyperthyroidism refers to an excess level of circulating thyroid hormones.

III. Examples of Clinical or Research Applications

- A. Evaluation of the general structure of the thyroid gland (e.g. nodular or diffuse enlargement) relative to its function. This may be useful in the differential diagnosis of hyperthyroidism, i.e. distinguishing Graves' disease from toxic nodular goiter, a distinction of significance in determining the therapeutic dosage of I-131 and predicting the outcome and potential side effects of therapy.

The Society of Nuclear Medicine (SNM) has written and approved these guidelines as an educational tool designed to promote the cost-effective use of high-quality nuclear medicine procedures or in the conduct of research and to assist practitioners in providing appropriate care for patients. The guidelines should not be deemed inclusive of all proper procedures nor exclusive of other procedures reasonably directed to obtaining the same results. They are neither inflexible rules nor requirements of practice and are not intended nor should they be used to establish a legal standard of care. For these reasons, SNM cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment about the propriety of any specific procedure or course of action must be made by the physician when considering the circumstances presented. Thus, an approach that differs from the guidelines is not necessarily below the standard of care. A conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in his or her reasonable judgment, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines.

All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

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

- B. Correlation of thyroid palpation with scintigraphic findings to determine the degree of function in a nodule that is palpable or found incidentally at a non-nuclear imaging procedure.
- C. Location of ectopic thyroid tissue (e.g., lingual, incomplete thyroid descent).
- D. Evaluation of congenital hypothyroidism (total agenesis or hemiagenesis, dyshormonogenesis, incomplete thyroid descent).
- E. Evaluation of a neck or substernal mass. Scintigraphy may be helpful to confirm that the mass is functioning thyroid tissue.
- F. Differentiation of thyroiditis (i.e. viral, autoimmune) and factitious hyperthyroidism from Graves' disease and other forms of hyperthyroidism.

IV. Procedure

A. Patient Preparation

1. Avoidance of interfering materials

The concentration of radioiodine by the thyroid is affected by many factors:

- a. Medications, such as thyroid hormones and antithyroid drugs.
- b. Iodine-containing food (e.g. kelp) and medications (e.g. iodinated contrast, amiodarone, betadine)

Except under very specific circumstances (e.g. to determine if a nodule is autonomous), thyroid scintigraphy should be delayed for a period long enough to eliminate the effects of these interfering factors (see SNM Procedure Guideline for Thyroid Uptake Measurement). In hyperthyroidism there is a more rapid clearance of iodine, thus successful imaging can often be obtained sooner than is stated in the literature discussing interference of stable iodine with radioiodine uptake measurement.

B. Information Pertinent to Performing the Procedure

1. Pregnancy/lactation/nursing status. Pregnancy must be excluded in accordance with the local institutional policy. If the patient is breast-feeding, appropriate radiation safety instructions should be given to her.

2. Pertinent clinical history (symptoms and signs of hyper- or hypothyroidism)
3. History of interfering medications (e.g. thyroid hormones, antithyroid drugs, iodine-containing medications)
4. Prior exposure to iodinated contrast
5. Ingestion of iodine-rich foods (often found in health food stores including kelp)
6. Pertinent laboratory data, including results of thyroid function tests
7. Results of prior thyroid imaging tests (CT, MRI, ultrasound) if available
8. Results of prior thyroid uptake measurement
9. History of recently administered radionuclides
10. Findings on physical examination of the neck

C. Precautions

None

D. Radiopharmaceutical

1. Comparison of Radiopharmaceuticals for Thyroid Scintigraphy

Radiopharmaceutical	Advantages	Disadvantages
Tc-99m Pertechnetate	<ul style="list-style-type: none"> • Less expensive • More readily available • More rapid examination 	<ul style="list-style-type: none"> • Trapped, but not organified • Activity in esophagus or vascular structures can be misleading • Poor image quality when uptake is low
I-123 iodide	<ul style="list-style-type: none"> • Better for visualization of retrosternal thyroid tissue • Yields better images when uptake is low 	<ul style="list-style-type: none"> • Higher cost • May be less convenient for patient, as delayed imaging at 24 hr is often used • Less readily available • Imaging times are generally longer

2. Because of the large radiation dose to the thyroid (approximately one to three rads per uCi administered), the use of I-131 for thyroid scintigraphy should be discouraged (except when a subsequent treatment with I-131 is planned).
3. Radiation Dosimetry

Radiation Dosimetry for Adults

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose Equivalent mSv/MBq (rem/mCi)
NaI-123 iodide*	7.5 – 25 p.o. (0.2 – 0.6)	3.2 Thyroid (12.0)	0.11 (0.41)
Tc-99m pertechnetate	75 – 370 i.v. (2 – 10)	0.062 ULI** (0.23)	0.013 (0.048)
NaI-131 iodide*	1.85 – 3.7 p.o. (0.05 – 0.1)	360 Thyroid (1300)	11 (41.0)

* assuming 25% uptake

** ULI – upper large intestine

References:

1. Michael G. Stabin, PhD, CHP: Radiation Internal Dose Information Center, Oak Ridge Institute for Science and Education, Oak Ridge, TN, 1996
2. ICRP Publication 53, Radiation Dose to Patients from Radiopharmaceuticals, 1994 edition
3. Loevinger R, Budinger T, Watson, E: MIRD Primer for Absorbed Dose Calculations, Society of Nuclear Medicine, 1991

Radiation Dosimetry for Children (5 year old)

Radiopharmaceutical	Administered Activity MBq/Kg (mCi/Kg)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose Equivalent mSv/MBq (rem/mCi)
NaI-123 iodide*	0.1 – 0.3 p.o. (0.003 – 0.01)	16 Thyroid (59)	0.54 (2.0)
Tc-99m pertechnetate	1.8-9.2 i.v. (0.05 – 0.25)	0.21 ULI** (0.78)	0.04 (0.15)

* assuming 25% uptake

** ULI – upper large intestine

References:

1. Michael G. Stabin, PhD, CHP: Radiation Internal Dose Information Center, Oak Ridge Institute for Science and Education, Oak Ridge, TN, 1996
2. ICRP Publication 53, Radiation Dose to Patients from Radiopharmaceuticals, 1994 edition
3. Loevinger R, Budinger T, Watson, E: MIRD Primer for Absorbed Dose Calculations, Society of Nuclear Medicine, 1991
4. An intramuscular injection of Tc-99m pertechnetate can also be used when venous access is difficult.

E. Image Acquisition

1. Instrumentation

- a. A gamma camera equipped with a pinhole collimator and an aperture 5 mm or less in diameter is conventionally used.

2. Patient positioning

The patient should be supine with the neck extended and supported by a pillow placed under the shoulders. In patients who are unable to lie supine, the sitting position may be employed.

3. Timing of images

- a. When Tc-99m pertechnetate is used, imaging should begin 15–30 min after injection.
- b. When I-123 is used, images can be obtained as early as 3–4 hr after radiotracer ingestion. Images obtained at 16–24 hr have the advantage of lower body background, but the disadvantage of a lower count rate. Interpretable images can be obtained as long as 36 hr after ingestion.
- c. When I-131 is used, images should be obtained at 16–24 hr after radiotracer ingestion.

4. Acquisition parameters

With Tc-99m, an anterior pinhole image is acquired for 100,000–200,000 counts or 5 min, whichever occurs first. With I-123, the corresponding

parameters are generally 50,000–100,000 counts or 10 min. Both anterior oblique images should be obtained for the same amount of time as the anterior image. The distance between the pinhole aperture and the neck should be adjusted so that the image of the thyroid occupies the central two-thirds of the field of view.

The thyroid should be palpated with the patient in position for imaging. Radioactive or radiopaque markers can be used to identify anatomical landmarks (e.g. sternal notch, thyroid cartilage) and the location of palpable nodules. Localizing markers for nodules should be centered in the field of view to avoid parallax. Duplicate views should be obtained without the markers.

Size markers are useful, but should be used with caution since the pinhole collimator will cause geometric distortion with depth. Exact sizing can be accomplished by using a parallel hole collimator and markers set at known distance.

F. Interventions

Asking the patient to rinse his/her mouth with water and to swallow a glass of water is sometimes useful to eliminate esophageal and mouth activity.

G. Processing

None

H. Interpretation Criteria

An adequate history and physical examination should be obtained, especially palpation of the thyroid. Localization of findings on palpation should be marked on the neck of the patient so that they can be correlated with the scintigraphic image.

Uniformity and intensity of the image of the thyroid and the background should be noted. The presence, absence, size, and location of areas of increased or decreased uptake should be described.

Variation in function of different areas of the thyroid should be noted, and comparison should be made of focal areas of increased or decreased function to background thyroid activity. Hyperfunctioning nodules may completely suppress the background activity in the remaining extranodular tissue. However, partial suppression of extranodular tissue is perhaps more common than total suppression. The availability of a recent serum TSH result is useful to help evaluate the degree of autonomy, since an area of focal uptake that is clearly

separate from lesser or absent activity in the rest of the thyroid would be expected to be associated with a suppressed TSH. Irregular uptake in nodular form is also seen in Hashimoto's thyroiditis and in multinodular goiter with interfocal regions of follicular destruction.

I. Reporting

Autonomous hyperfunctioning nodules are easily identified and rarely malignant. However, it is necessary to be certain that there is suppressed thyroid tissue outside of the nodule, and that the absence of such uptake does not represent agenesis of a thyroid lobe. Palpation and ultrasound might be useful if this is a question.

Localized areas of decreased function, when specifically correlated with a palpable nodule, may represent a hypofunctioning or "cold" nodule. Because of the difficulty in correlating findings on palpation with those on the scintigraphic image, efforts in localization using a "hot" marker placed on the nodule are important. It is also important to note that most hypofunctioning nodules do not represent malignancy but rather benign processes such as colloid nodules, follicular adenomas, cysts and, rarely, areas of fibrosis or localized thyroiditis.

Scintigraphy cannot define a "nodule", it only depicts a relative difference in functional activity. It is therefore inappropriate to interpret scintigraphic findings as thyroid nodules unless palpation has been carried out and an appropriate correlation made.

J. Quality Control

Routine QC for camera used for imaging; see Society of Nuclear Medicine Procedure Guideline for General Imaging.

K. Sources of Error

1. Local contamination (clothing, skin, hair, collimator, crystal)
1. Esophageal activity (hiatal hernia)
2. Suppression of iodine uptake by interfering substances

V. Issues Requiring Further Clarification

None

VI. Concise Bibliography

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VII. Last House of Delegates Approval Date:

February 7, 1999

VIII. Next Anticipated Approval Date:

September 10, 2006

IX. Appendix: Description of Guideline Development Process**A. Guideline Development Subcommittee**

Kevin J. Donohoe, MD (Chair); Helena R. Balon, MD; Paul E. Christian, CNMT; Peter S. Conti, MD, PhD; Dominique Delbeke, MD, PhD; Marcelo F. Di Carli, MD; Ernest V. Garcia, PhD; D. Scott Hollbrook, CNMT; Lale Kostakoglu, MD; David H. Lewis, MD; Josef Machac, MD; J. Anthony Parker, MD, PhD; Henry D. Royal, MD; Barry L. Shulkin, MD; Barry A. Siegel, MD; Alan D. Waxman, MD; Mark D. Wittry, MD

B. Task Force Chair and Members

Helena R. Balon, MD (Chair); Edward B. Silberstein, MD; Donald A Meier, MD; N. David Charkes, MD, Salil D. Sarkar, MD; Henry D. Royal, MD; Kevin J. Donohoe, MD

C. History of House of Delegates Approval Dates

V1.0 February 12, 1995

V2.0 February 7, 1999

D. Revision History**1. Version 2.1**

- a. Names of each detailed reviewer and the percentage of lines with which the reviewer agreed:

Helena R. Balon, MD (96%); Edward B. Silberstein, MD (96%); N. David Charkes, MD (98%)

- b. Names of other reviewers:

- c. Line-by-line listing of all comments and the action taken on each comment (Fully Implemented; Partially Implemented; Not Implemented).

See Line-by-Line Comment Report on file – *Procedure Guideline for Thyroid Uptake Measurement V2.1*.

- d. Date completed: May 10, 2006

2. Version 2.2

- a. Names of each detailed reviewer and the percentage of lines with which the reviewer agreed:

Kevin J. Donohoe (95%); N. David Charkes, MD (99%); Salil D. Sarkar, MD (96%); Donald A. Meier, MD (98%)

- b. Names of other reviewers:
- c. Line-by-line listing of all comments and the action taken on each comment (Fully Implemented; Partially Implemented; Not Implemented).

See Line-by-Line Comment Report on file – *Procedure Guideline for Thyroid Uptake Measurement V2.2.*

- d. Date completed: July 4, 2006

3. Version 2.3

- a. Names of each detailed reviewer and the percentage of lines with which the reviewer agreed:

Edward B. Silberstein, MD (99%)

- b. Names of other reviewers:
- c. Line-by-line listing of all comments and the action taken on each comment (Fully Implemented; Partially Implemented; Not Implemented).

See Line-by-Line Comment Report on file – *Procedure Guideline for Thyroid Uptake Measurement V2.3.*

- d. Date completed: August 1, 2006

4. Version 2.4

- e. Names of each detailed reviewer and the percentage of lines with which the reviewer agreed:

All (100%)

- b. Names of other reviewers:
- c. Line-by-line listing of all comments and the action taken on each comment (Fully Implemented; Partially Implemented; Not Implemented).

See Line-by-Line Comment Report on file – *Procedure Guideline for Thyroid Uptake Measurement V2.4.*

- d. Date completed: September 5, 2006