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 ingestion of radioactive iodine (I-131).

In this document, hyperthyroidism refers to an excess level of circulating thyroid hormone due to a stimulated thyroid gland, as well as due to other causes.

III. Common Indications

A. To relate the general structure of the thyroid gland (e.g. nodular or diffuse enlargement) to its function. This may be useful in distinguishing Graves' disease from toxic nodular goiter, a distinction of significance in determining the amount of I-131 to be given as therapy for hyperthyroidism.

B. To correlate thyroid palpation with scintigraphic findings to determine the degree of function in a clinically-defined area or nodule (i.e. palpable).

C. To locate ectopic thyroid tissue (i.e. lingual) or determine whether a suspected "thyroglossal duct cyst" is the only functioning thyroid tissue present.

D. To assist in evaluation of congenital hypothyroidism.

E. To evaluate a neck or substernal mass. Radionuclide scintigraphy may be helpful to confirm that the mass is functioning thyroid tissue.

F. To differentiate thyroiditis (i.e. subacute or silent) and factitious hyperthyroidism from Graves' disease and other forms of hyperthyroidism.

IV. Procedure

A. Patient Preparation

<u>It is important to ensure that the patient is not pregnant or lactating.</u>

1. Avoidance of Interfering Materials

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

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)

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.

B. Information Pertinent to Performing the Procedure

1. Pregnancy / lactation / nursing status
2. Possibility of interfering medications (e.g. thyroid hormone, antithyroid drugs, iodine-containing medications)
3. Prior iodinated contrast
4. Ingestion of iodine-rich foods
5. Pertinent laboratory data, including results of thyroid function tests
6. Results of prior thyroid imaging tests
7. Results of prior thyroid uptake
8. Recently administered radionuclides

C. Precautions

None

Comparison of Radiopharmaceuticals for Thyroid Scintigraphy

Radionuclide	Advantages	Disadvantages
Tc-99m pertechnetate	• Less expensive • More readily available • More rapid examination	• Trapped, but not organified • Activity in esophagus or vascular structures can be misleading • Poor image quality when uptake is low
I-123 iodide	• Better for visualization of retrosternal thyroid tissue • Yields better images when uptake is low	• 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

D. Radiopharmaceutical
   1. Comparison of Radiopharmaceuticals for Thyroid Scintigraphy (see Table above)
   2. Because of the large radiation dose to the thyroid (approximately one to three rads per μCi 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 (see Table below)
   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.
      b. Rectilinear scanning of the thyroid may also be used for thyroid imaging.
      Compared to gamma cameras, scanners are better able to estimate the size of the thyroid and correlate the location (relative to other anatomical landmarks) of thyroid nodules.
   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

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-131 iodide[1]	1.85 – 7.4 p.o. (0.05 – 0.2)	210 Thyroid (780)	6.6 (24.0)
Na-I-123 iodide[2]	7.5 – 25 p.o. (0.2 – 0.6)	1.9 Thyroid (7.0)	0.075 (0.28)
Tc-99m pertechnetate[3]	75 – 370 i.v. (2 – 10)	0.062 ULI[4] (0.23)	0.013 (0.048)

[1]ICRP 53, page 276, assuming 15% uptake
[2]ICRP 53, page 264, assuming 15% uptake
[3]ICRP 53, page 199, no blocking agent
[4]Upper Large Intestine
*Per MBq (per mCi)

Radiation Dosimetry in Children (5 year old)

Radiopharmaceutical	Administered Activity MBq/Kg (mCi/Kg)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose* mSv (rem)
Na-I-131 iodide[1]	0.025 – 0.1 p.o. (0.0004 – 0.0016)	1,100 Thyroid (4,100)	34 (130)
Na-I-123 iodide[2]	0.1 – 0.3 p.o. (0.003 – 0.01)	9.8 Thyroid (36)	0.35 (1.3)
Tc-99m pertechnetate[3]	1 – 5 i.v. (0.015 – 0.07)	0.21 ULI[4] (0.78)	0.04 (0.15)

[1]ICRP 53, page 276, assuming 15% uptake
[2]ICRP 53, page 264, assuming 15% uptake
[3]ICRP 53, page 199, no blocking agent
[4]Upper Large Intestine
*Per MBq (per mCi)

as early as 3–4 hr after ingesting the tracer. 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, the images should be obtained at 16–24 hr after ingesting the radioiodine.

4. Acquisition parameters

With Tc-99m, an anterior 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 should 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.

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. Information from ultrasound or other diagnostic imaging procedures should be available for comparison with the images obtained by radionuclide studies.

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 by comparison to background thyroid activity. Hyperfunctioning nodules may completely suppress the background activity in the

remaining extranodular thyroid activity. However, partial suppression of extranodular tissue is perhaps more common than total suppression. The availability of a serum TSH measurement 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.

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 significant 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, before a specific nodule is defined as cold, efforts in localization using a "hot" marker placed on the nodule are important for confirmation. It is also important to note that most cold nodules do not represent malignancy and most hypofunctioning nodules represent non-specific thyroid pathology, most often localized areas of fibrosis, thyroiditis or a cyst.

Scintigraphy cannot define a "nodule"; it only represents a 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)
2. Esophageal activity (hiatal hernia)

V. Issues Requiring Further Clarification

None

VI. Concise Bibliography

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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.