

THYROID UPTAKE MEASUREMENT (I-123 or I-131 as Sodium Iodide)

Overview

- The Thyroid Uptake Measurement measures the metabolic activity of the thyroid gland as reflected by its extraction of iodine from the blood.

Indications

- Diagnosis of Grave's disease (1,2).
- Evaluation of subacute and chronic thyroiditis (3).

Examination Time

- Initially: 20 minutes for radiopharmaceutical administration.
- Delayed measurement at 6 hours: 15 minutes.

Patient Preparation

- Must be off thyroid hormones (4,5):
 1. Thyroxine (T-4) for at least 10 days.
 2. Triiodothyronine (T-3) for at least 3 days.
- Must not be taking antithyroid medications (4,5):
 1. Propylthiouracil (PTU) and tapazole for at least 3 days.
- Must not have had intravenous or intrathecal iodinated contrast material (CT with intravenous contrast, IVP, myelogram, angiogram) for at least 3 weeks (1).
- Other agents may interfere, but usually only to a small extent (6).
- NPO after midnight the night before and for at least 1 hour after ingesting the radiopharmaceutical.

Equipment & Energy Windows

- Detector: Uptake probe (single crystal probe with flat field collimator).
 - θ A gamma camera may be substituted for a dedicated uptake probe.
- Energy window:
 - > I-123: 20% window centered at 159 keV.

- > I-131: 20% window centered at 364 keV.
- Neck phantom.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical:
 - > If part of an I-123 imaging study: The same radiopharmaceutical is used for both studies (The radiopharmaceutical should have minimal amounts of I-124 contamination) (7-9).
 - > If not part of an I-123 imaging study: I-123 or I-131 (7).
- Dose:
 - > Imaging plus uptake studies: I-123: 500 μ Ci (18.5 MBq).
 - > Uptake study only:
 - θ I-123: 100 μ Ci (1.9 MBq) or
 - θ I-131: 10 μ Ci (0.37 MBq).
- Technique of administration: Oral.

Patient Position & Imaging Field

- Patient position: Sitting.
- Detector field of view: Neck.

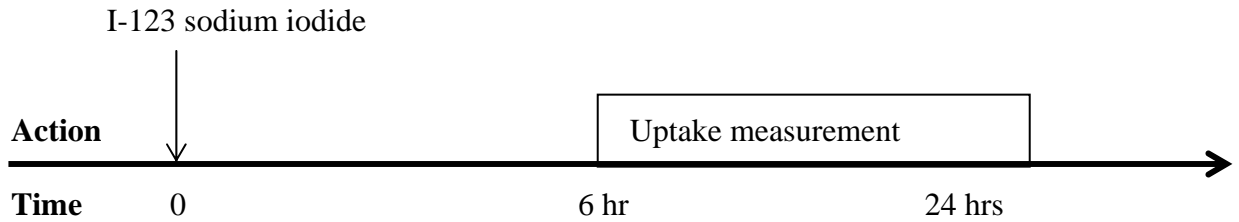
Acquisition Protocol

- Place radiopharmaceutical capsule(s) in neck phantom and position probe perpendicular to phantom with the positioning bar centered on capsule(s) at a standard distance, usually 20 cm (10).
- Acquire counts for 1 minute for I-123 and for 2 minutes for I-131; record the counts, time of acquisition, and time of day on the Thyroid Uptake Worksheet.
- Immediately administer the capsule(s) to the patient.
- At 6 hours position the probe in front of the patient's neck with the positioning bar perpendicular to the neck and with the bar centered half way between the thyroid cartilage and the suprasternal notch.
- Acquire counts for 1 minute for I-123 and for 2 minutes for I-131; record the counts, time of acquisition, and time of day on the Worksheet.
- Position the probe over the thigh for 6 hour "background" measurement. The positioning bar should be perpendicular to the thigh with the bar centered just

above the knee. The patient should void before counting over the thigh and the bladder must be clearly outside of the field of view.

- Acquire counts for 1 minute for I-123 and for 2 minutes for I-131; record the counts, time of acquisition, and time of day on the Worksheet.

Protocol Summary Diagram



Data Processing

- Using the Thyroid Uptake Worksheet, calculate the 6 hour thyroid uptakes. Remember to correct the standard counts for decay.

Optional Maneuvers

- Twenty four hour uptake measurement: May be performed, but adds little to
- Uptake measurement with a gamma camera: A gamma camera with a pinhole or parallel collimator may be substituted for an uptake probe (15).
- Thyroid uptake measurements may be determined using Tc-99m-pertechnetate (17).
- Perchlorate washout test may be used to detect iodide organification defects (18,19):
 1. Administer approximately 10 μ Ci of I-131 orally.
 2. At 2 hours determine thyroid uptake value.
 3. Give 1,000 mg of perchlorate orally (600 mg for children).
 4. At 3 hours (1 hour later) determine a second thyroid uptake value.
 5. An abnormal response is a decrease in the uptake value of greater than 5%.

Principle Radiation Emission Data - I-123 (20)

- Physical half-life = 13.2 hours.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	83.3	159.0
ce-K, gamma-2	13.6	127.2

Dosimetry - I-123 as Sodium Iodide (21)

Organ	rads/500 μ Ci	mGy/18.5 MBq
Thyroid	3.75	37.5
Stomach wall	0.12	1.2
Ovaries	0.02	0.2
Red marrow	0.02	0.2
Liver	0.01	0.1
Whole body	0.01	0.1
Testes	0.01	0.1

Principle Radiation Emission Data - I-131 (22)

- Physical half-life = 8.04 days.

Radiation	Mean % per disintegration	Mean energy (keV)
Beta-4	89.4	191.5
Gamma-14	81.2	364.5

Dosimetry - I-131 as Sodium Iodide (21)

Organ	rads/10 μ Ci	mGy/0.37 MBq
Thyroid	13.00	130.0
Stomach wall	0.01	0.1
Total body	0.01	0.1
Ovaries	0.01	0.1
Testes	0.01	0.1

References

- Koplowitz JM, Solomon DH: Tests of thyroid function. In Nuclear Medicine, WH Bland, ed, McGraw-Hill, New York, 1971, pp 187-226.
- Klonecke A, Petersen MM, McDougall IR: Thyrotoxicosis with low thyroidal uptake of radioiodine. Sem Nucl Med 20:364-366, 1990.
- Hamburger JK: Subacute thyroiditis: Diagnostic difficulties and simple treatment. J Nucl Med 15:81-89, 1974.
- Schultz AL, Jacobson WE: The effect of propylthiouracil on thyroid uptake of I-131 and the plasma conversion ratio in hyperthyroidism. J Clin Endocrinol 12:1205-1214, 1952.
- Greer MA: The effect on endogenous thyroid activity of feeding dessicated thyroid to normal human subjects. New Engl J Med 244:385, 1951.

6. Blum M, Braverman LE, Holliday RA, et al: Thyroid uptake test. In Principles of Nuclear Medicine, 2nd ed, WB Saunders, 1995, pp 598-600.
7. Robertson JS, Verhasselt M, Wahner GW: Use of I-123 for thyroid uptake measurements and depression of I-131 thyroid uptakes by incomplete dissolution of capsule filler. J Nucl Med 15:770-774, 1974.
8. Green JP, Wilcox JR, Marriott JD, et al: Thyroid uptake of I-131: Further comparisons of capsules and liquid preparations. J Nucl Med 17:310-312, 1976.
9. Hughes JA, Williams CC, Thomas SR, et al: Potential errors caused by variable radionuclide purity of iodine-123. J Nucl Med Technol 7:167-170, 1979.
10. Vahjen GA, Lange RC, Merola TF: Thyroid uptake neck phantoms are not created equal. J Nucl Med 33:304-305, 1992.
11. Floyd JL, Rosen PR, Borchert RD, et al: Thyroid uptake and imaging with iodine-123 at 4-5 hours: Replacement of the 24-hour iodine-131 standard. J Nucl Med 26:884-887, 1985.
12. Hayes AA, Akre CM, Gorman CA: Iodine-131 treatment of Graves' disease using modified early iodine-131 uptake measurements in therapy dose calculations. J Nucl Med 31:519-522, 1990.
13. Aktay R, Rezai K, Seabold JE, et al: Four- to twenty-four-hour uptake ratio: An index of rapid iodine-131 turnover in hyperthyroidism. J Nucl Med 37:1815-1819, 1996..
14. Hennessey JV, Berg LA, Ibrahim MA, et al: Evaluation of early (5 to 6 hours) iodine 123 uptake for diagnosis and treatment planning in Grave's disease. Arch Intern Med 155:621-624, 1995.
15. Robeson WR, Ellwood JE, Castronuovo JJ, et al: A new method to measure thyroid uptake with a gamma camera without routine use of a standard source. Clin Nucl Med 27:324-329, 2002.
16. Smith JJ, Croft BY, Brookeman VA, et al: Estimation of 24-hour thyroid uptake of I-131 sodium iodide using a 5-minute uptake of technetium-99m pertechnetate. Clin Nucl Med 15:80-83, 1990.
17. El-Desouki M, Al-Jurayyan N, Al-Nuaim A, et al: Thyroid scintigraphy and perchlorate discharge test in the diagnosis of congenital hypothyroidism. Eur J Nucl Med 22:1005-1008, 1995.
18. Stewart RDH, Murray IPC: An evaluation of the perchlorate discharge test. J Clin Endocr 26:1050, 1966.
19. 53-I-123. In MIRD: Radionuclide data and decay schemes, DA Weber, KF Eckerman, LT Dillman, JC Ryman, eds, Society Nuclear Medicine, New York, 1989, p 217.
20. MIRD Dose Estimate Report No. 5: Summary of current radiation dose estimates to humans from I-123, I-124, I-126, I-130, I-131, I-132 as sodium iodide. J Nucl Med 16:857-860, 1975.
21. 53-I-131. In MIRD: Radionuclide data and decay schemes, DA Weber, KF Eckerman, LT Dillman, JC Ryman, eds, Society Nuclear Medicine, New York, 1989, p 228.

Normal Values

- > Robertson JS, Nolan MG, Wahner HW, et al: Thyroid radioiodine uptakes and scans in euthyroid patients. Mayo Clin Proc 50:79-84, 1975.
- > Hooper PL, Turner JR, Conway MJ, et al: Thyroid uptake of I-123 in a normal population. Arch Intern Med 140:757-758, 1980.
- > Anderson BG, Powsner RA: Stability of values for thyroid radioiodine uptake. J Nucl Med 37:805-806, 1996.
- > Normal thyroid uptake values in Denver, Colorado: 6 hours = 7-20%, 24 hours = 14-30%. University of Colorado Medical School, Unpublished data, 1981.

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THYROID UPTAKE WORKSHEET

Nuclear Medicine Department

Institution _____

Name _____ ID _____ Age _____ Sex _____
 Referring physician _____ Date _____

Zero Hour (time _____)

	counts per minute
Dose in phantom (standard)	
Background	-
Net (standard)	

6 Hour Uptake (time _____)

	counts per minute
Neck	
Thigh (background)	-
Net	

	counts per minute
Standard at zero time	
Decay correction factor	x
Corrected standard	

6 hour uptake = (net neck cpm / corrected standard cpm) x 100% = _____%

24 Hour Uptake (time _____)

	counts per minute
Neck	
Thigh (background)	-
Net	

	counts per minute
Standard at zero time	
Decay correction factor	x
Corrected standard	

24 hour uptake = (net neck cpm / corrected standard cpm) x 100% = _____%

- Normal Range: 6 hours = _____%; 24 hours = _____% •

Technologist _____