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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF PARATHYROID SCINTIGRAPHY

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, 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. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and

complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. It should be recognized; therefore, that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. 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.

I. INTRODUCTION

This guideline has been developed by the American College of Radiology (ACR) to guide interpreting physicians performing parathyroid scintigraphy in adult and pediatric patients. Properly performed imaging with radiopharmaceuticals that localize in parathyroid tissue is a sensitive means of detecting parathyroid adenomas, carcinomas, and parathyroid hyperplasia in patients with known hyperparathyroidism. As with all nuclear medicine studies, scintigraphic findings must be correlated with clinical information and other imaging modalities.

Application of this guideline should be in accordance with the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

(For pediatric considerations see Section V.A.3.)

II. GOAL

The goal of parathyroid scintigraphy is to produce images of diagnostic quality to detect enlarged and/or hyperfunctioning parathyroid tissue in normal or ectopic locations.

III. INDICATIONS

Parathyroid scintigraphy may be used either prior to surgery to facilitate identification and removal of abnormal parathyroid tissue or subsequent to surgery in patients with persistent or recurrent hyperparathyroidism to detect aberrant or ectopic hyperplastic or neoplastic glands.

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

V. SPECIFICATIONS OF THE EXAMINATION

A. Radiopharmaceuticals

1. Radiopharmaceuticals taken up by the thyroid in proportion to thyroid function (see the [ACR Practice Guideline for the Performance of Thyroid Scintigraphy and Uptake Measurements](#))
 - a. Technetium-99m pertechnetate, given intravenously in an administered activity of 1-10 millicuries (37-370 MBq), depending on the protocol used, is trapped by the follicular cells of the thyroid.
 - b. Iodine-123 (sodium iodide), given orally in an administered activity of 200-600 microcuries (7.5-22 MBq), is trapped and organified by the follicular cells of the thyroid.
2. Radiopharmaceuticals localizing in parathyroid and thyroid tissue
 - a. Thallium-201 (thallous chloride), given intravenously in an administered activity of 2.0-3.5 millicuries (74-130 MBq), is a potassium analog and is taken into both thyroid and parathyroid tissue in proportion to local blood flow.
 - b. Technetium-99m sestamibi or technetium-99m tetrofosmin given intravenously in an administered activity of 20-30 millicuries (740-1,110 MBq) localizes in both thyroid and parathyroid tissues in proportion to local blood flow and metabolism. Its rate of

disappearance from hyperplastic and neoplastic parathyroid is usually slower than from the normal thyroid and parathyroid.

3. Administered activity for children should be reduced according to body surface area or weight. The pediatric administered activity should be as low as possible to achieve appropriate image quality.

B. Examination

Two different strategies have been described: dual and single radiopharmaceutical. No matter which strategy is used, it is important to image the neck, chest, and mediastinum to evaluate for ectopic parathyroid tissue. Single-photon-emission computed tomography (SPECT) imaging may also be helpful.

1. Dual radiopharmaceutical

In this strategy, an image generated from injection of a radiopharmaceutical that accumulates only in thyroid tissue (technetium-99m pertechnetate or iodine-123) is subtracted digitally or by qualitative visual comparison from an image acquired after administration of an agent that localizes in both thyroid and parathyroid tissue (thallium-201, technetium-99m sestamibi, or technetium-99m tetrofosmin). Imaging relies on utilizing either different photopeaks of two agents, as in technetium-99m pertechnetate/thallium-201 and iodine-123/technetium-99m sestamibi, or technetium-99m tetrofosmin, or markedly differing injected activities of technetium-99m-based radiopharmaceuticals, as in technetium-99m pertechnetate, technetium-99m sestamibi or technetium-99m tetrofosmin. Two approaches are used. In the first, the thyroid-seeking radiopharmaceutical is given first. In the second, the parathyroid agent precedes the thyroid radiotracer.

a. Thyroid-seeking agent first

- i. Technetium-99m pertechnetate/thallium-201, iodine-123/technetium-99m sestamibi or technetium-99m tetrofosmin

A single anterior image of the thyroid gland is acquired for about 300,000-500,000 counts or 5 minutes, 15-30 minutes after administration of technetium-99m pertechnetate or 3 hours after administration of iodine-123. The energy window is set for the appropriate photo peak.

The energy window is then adjusted for the parathyroid radiopharmaceutical photo peak, and a 5-minute “subtraction mask” image is obtained.

Without moving the patient, the parathyroid radiopharmaceutical is then injected, and serial 5-minute images are obtained at the appropriate photo peak over a period of 20-30 minutes.

The “subtraction mask” image is digitally subtracted from the parathyroid images. The thyroid image is “normalized” (digitally multiplied or divided) so that roughly equal counts are present in the thyroid in both sets of images. The thyroid images may then be subtracted digitally from the parathyroid images.

Qualitative visual comparison of thyroid image(s) with parathyroid image(s) is made to detect tissue that is seen on the latter but is not present on the former.

ii. Technetium-99m pertechnetate/technetium-99m sestamibi or technetium-99m tetrofosmin

A low administered activity of technetium-99m pertechnetate (1-2 millicuries [37-74 MBq]) is given intravenously, and a thyroid image is obtained 15 minutes after the injection. Immediately following this image, and without moving the patient, approximately 20 millicuries (740 MBq) of technetium-99m sestamibi or technetium-99m tetrofosmin is injected, and sequential anterior images of the thyroid bed are obtained for 15-20 minutes. Following normalization as described in Section V.B.1.a.i. above, the low administered activity technetium-99m pertechnetate image is digitally subtracted from the high administered activity sestamibi or tetrofosmin image to reveal discordant parathyroid uptake.

b. Parathyroid-seeking agent first

Technetium-99m sestamibi or technetium-99m tetrofosmin/ technetium-99m pertechnetate

An administered activity of 20 millicuries (740 MBq) technetium-99m sestamibi is given intravenously. Anterior images of the neck are obtained 15 minutes later with a pinhole collimator (optional oblique views can also be obtained) followed by a parallel-hole collimator view of the neck and chest (optional SPECT images can also be obtained). Two hours post-injection, a repeat parallel-hole collimator view of the neck and chest is performed, followed by an anterior pinhole image of the neck. An administered activity of 10 millicuries (370 MBq) of technetium-99m pertechnetate can be given immediately after delayed sestamibi images. Anterior (and optional oblique) pinhole images of the neck are obtained 15 minutes after injection. Discordant sestamibi activity not seen on pertechnetate images indicates abnormal parathyroid tissue. Optional computer digital subtraction images can be obtained, but every effort should be made so that the patients are in the same position when the two images to be subtracted are obtained.

2. Single radiopharmaceutical

Technetium-99m sestamibi or technetium-99m tetrofosmin is given intravenously, and an anterior image of the neck is obtained at 10-15 minutes and again at 120-180 minutes. Oblique images may also be helpful. Because parathyroid adenomas and hyperplastic tissue usually retain the radiopharmaceutical for a longer period of time than does normal thyroid tissue, they appear as areas of increased activity on the delayed image. Comparison of washout curves drawn over regions thought to represent adenomas with curves from “normal tissue” may be helpful. SPECT images of the neck and chest may be helpful. Since some parathyroid adenomas wash out technetium-99m sestamibi or technetium-99m tetrofosmin rapidly, the sensitivity of this single radiopharmaceutical technique is not as high as dual-isotope techniques.

VI. EQUIPMENT SPECIFICATIONS

Any gamma camera may be used. Pinhole collimation is required for thyroid bed imaging, with parallel-hole collimation for imaging the chest and mediastinum.

Computer acquisition is necessary for the dual-radiopharmaceutical technique with subtraction. It is often helpful for qualitative visual analysis in single-radiopharmaceutical studies as well. At a minimum, a 128 x 128 matrix (pixel size ≤ 4 mm) is needed.

VII. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Guideline for Communication: Diagnostic Radiology](#).

VIII. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION CONCERNS

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Nuclear Medicine Imaging Equipment](#).

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R. Edward Coleman, MD, Chair
Gary L. Dillehay, MD
Michael J. Gelfand, MD
L. Stephen Graham, PhD
Kathryn A. Morton, MD
Sara M. O'Hara, MD
John O. Olsen, MD
Alice M. Scheff, MD
Kenneth M. Spicer, MD

Milton J. Guibertau, MD, Chair, Commission

REFERENCES

1. Casas AT, Burke GJ, Mansberger AR Jr, et al. Impact of technetium-99m sestamibi localization on

operative time and success of operations for primary hyperparathyroidism. *Am Surg* 1994; 60:12–16.

2. Chen CC, Skarulis MC, Fraker DL, et al. Technetium-99m sestamibi imaging before reoperation for primary hyperparathyroidism. *J Nucl Med* 1995; 36:2186–2191.
3. Chen CC, Holder LE, Scovill WA, et al. Comparison of parathyroid imaging with technetium-99m-pertechnetate/sestamibi subtraction, double-phase technetium-99m-sestamibi and technetium-99m-sestamibi SPECT. *J Nucl Med* 1997; 38:834–839.
4. Aigner RM, Fueger GF, Nicoletti R. Parathyroid scintigraphy: comparison of technetium-99m-methoxyiso-butylisonitrile and technetium-99m-tetrofosmin studies. *Eur J Nucl Med* 1996; 23:693–696.
5. Martin WH, Sandler MP. Parathyroid glands. In: Sandler MP, Coleman RE, Patton JA, et al. *Diagnostic nuclear medicine*. 3rd ed. Baltimore, Md: Williams & Wilkins, 2003:671–696.
6. Fjeld JG, Erichsen K, Pfeffer PF, et al. Technetium-99m-tetrofosmin for parathyroid scintigraphy: a comparison with sestamibi. *J Nucl Med* 1997; 38:831–834.
7. Greenspan BS, Brown ML, Dillehay GL, et al. Procedure guideline for parathyroid scintigraphy. *J Nucl Med* 1998; 39:1111–1114.
8. Hindie E, Melliere D, Jeanguillaume C, et al. Parathyroid imaging using simultaneous double-window recording of technetium-99m-sestamibi and iodine-123. *J Nucl Med* 1998; 39:1100–1105.
9. Ishibashi M, Nishida H, Strauss HW, et al. Localization of parathyroid glands using technetium-99m-tetrofosmin imaging. *J Nucl Med* 1997; 38:706–711.
10. Lee VS, Wilkinson RH Jr, Leicht GS Jr, et al. Hyperparathyroidism in high-risk surgical patients: evaluation with double-phase technetium-99m sestamibi imaging. *Radiology* 1995; 197:627–633.
11. McBiles M, Lambert AT, Cote MG, et al. Sestamibi parathyroid images. *Semin Nucl Med* 1995; 25:221–234.
12. Neumann DR. Simultaneous dual-isotope SPECT imaging for the detection and characterization of parathyroid pathology. *J Nucl Med* 1992; 33:131–134.
13. Taillefer R, Boucher Y, Potvin C, et al. Detection and localization of parathyroid adenomas in patients with hyperparathyroidism using a single radionuclide imaging procedure with technetium-99m sestamibi (double phase study). *J Nucl Med* 1992; 33:1801–1807.
14. Winzelberg GG, Hydovitz JD. Radionuclide imaging of parathyroid tumors: historical perspectives and new techniques. *Semin Nucl Med* 1985; 15:161–170.