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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.

Revised 2009 (Res. 16)*

ACR–SNM–SPR 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 of 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.

Therefore, it should be recognized 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 was revised collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Nuclear Medicine (SNM).

It is intended to guide interpreting physicians performing parathyroid scintigraphy in adult and pediatric patients. Properly performed imaging with radio-pharmaceuticals that localize in parathyroid tissue is a sensitive means of detecting parathyroid adenomas. These studies may also detect parathyroid hyperplasia and carcinomas 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 sections V.A.2.b and V.A.3.)

II. GOAL

The goal of parathyroid scintigraphy is to produce images of diagnostic quality to assist in the detection and localization of enlarged and hyperfunctioning parathyroid tissue in normal or ectopic locations in patients with clinical hyperparathyroidism as shown by elevated levels of serum ionized calcium and parathyroid hormone.

III. INDICATIONS AND CONTRAINDICATIONS

Parathyroid scintigraphy is used 1) to identify and localize parathyroid tissue prior to surgery and 2) to facilitate and expedite surgical excision. It may also be used in postoperative patients with persistent or recurrent hyperparathyroidism to detect persistent, aberrant or ectopic parathyroid tissue, and to help reduce surgical time.

For the pregnant or potentially pregnant patient, see the ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation.

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

V. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for parathyroid scintigraphy should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

A. Radiopharmaceuticals

1. Radiopharmaceuticals taken up by the thyroid in proportion to thyroid function (see the ACR–SNM–SPR Practice Guideline for the Performance of Thyroid Scintigraphy and Uptake Measurements).
 - a. Technetium-99m pertechnetate, given intravenously in an administered activity of 1 to 10 millicuries (37 to 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 to 600 microcuries (7.5 to 22 MBq), is trapped and organified by the follicular cells of the thyroid.
2. Radiopharmaceuticals localizing in parathyroid and thyroid tissue
 - a. Technetium-99m sestamibi or technetium-99m tetrofosmin given intravenously in an administered activity of 20 to 30 millicuries (740 to 1,110 MBq) localizes in both thyroid and parathyroid tissues in proportion to local blood flow and metabolism. Their rate of clearance from hyperplastic and neoplastic parathyroid tissue is usually slower than from the normal thyroid and parathyroid. Technetium-99m sestamibi is more widely accepted.
 - b. Thallium-201 chloride given intravenously in an administered activity of 2.0 to 3.5 millicuries (74 to 130 MBq) behaves physiologically like potassium and is taken into both thyroid and parathyroid tissue in proportion to local blood flow. Because of the higher radiation exposure associated with its use, thallium-201 chloride is not recommended in the pediatric population.
3. Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

B. Examination

Two different strategies have been described: single and dual radiopharmaceutical. For either strategy, it is important to image the neck, chest, and mediastinum to evaluate for ectopic parathyroid tissue. Single-photon-emission computed tomography (SPECT) imaging separately or together with computed tomography (SPECT/CT) may also be helpful.

1. Single radiopharmaceutical

Technetium-99m sestamibi or technetium-99m tetrofosmin is given intravenously. An anterior planar image of the neck is obtained at 10 to 30 minutes and again at 90 to 180 minutes. Anterior oblique images may also be helpful. SPECT images of the neck and chest may increase sensitivity of detection and aid in localization. SPECT/CT may facilitate more accurate anatomic localization of the abnormal focus on the accompanying CT scan.

Because parathyroid adenomas and hyperplastic tissue usually retain the radiopharmaceutical for a longer period of time than normal thyroid tissue, they appear as areas of increased activity on the delayed image. Comparison of wash-out 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. The single isotope technique is the most commonly used. However, some parathyroid adenomas have more rapid wash-out of technetium-99m sestamibi or technetium-99m tetrofosmin, and the single isotope technique has slightly less sensitivity than the dual isotope techniques. (The single isotope technique depends on differential washout, so adenomas with rapid washout may be difficult to detect.)

2. Dual radiopharmaceutical

In this strategy, an image acquired after the administration 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 using either different photopeaks of 2 agents or on using markedly different injected activities of the technetium-99m-based radiopharmaceuticals. 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
 - ii. Iodine-123/technetium-99m sestamibi
 - iii. Iodine-123/technetium-99m tetrofosmin

A single anterior image of the thyroid gland is acquired for about 300,000 to 500,000 counts or 5 minutes, 15 to 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 technetium-99m parathyroid radiopharmaceutical photo peak, and a 5-minute image is obtained.

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

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.

Thyroid images and parathyroid images are qualitatively compared to detect tissue uptake that is seen on the latter but is not present on the former.

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

A low administered activity of technetium-99m pertechnetate (1 to 2 millicuries [37 to 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 to 20 minutes. Following normalization as described 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 approximately 20 millicuries (740 MBq) of technetium-99m sestamibi or tetrofosmin is given intravenously. Anterior images of the neck are obtained 15 minutes later with a pinhole collimator followed by a parallel-hole collimator view of the neck and chest. Anterior oblique images may also be helpful. SPECT images of the neck and chest may increase sensitivity of detection and aid in localization. SPECT/CT may facilitate more accurate anatomic localization of the abnormal focus on the accompanying CT scan.

Two hours after injection, a repeat parallel-hole collimator view of the neck and chest is performed, followed by an anterior pinhole image of the neck. Approximately 10 millicuries (370 MBq) of technetium-99m pertechnetate is given intravenously after delayed sestamibi or tetrofosmin images. Anterior (and optional oblique) pinhole images of the neck are obtained 15 minutes after injection. Discordant sestamibi or tetrofosmin activity not seen on pertechnetate images indicates abnormal parathyroid tissue. Optional computer digital subtraction images may be obtained, but the position of the patient must be the same position in the 2 images to be subtracted.

VI. EQUIPMENT SPECIFICATIONS

Any gamma camera may be used. Parallel-hole collimation is the standard for imaging the neck, chest, and mediastinum. Pinhole collimation should be used for better evaluation of the thyroid bed, if available.

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 of Diagnostic Imaging Findings.

The report should include the radiopharmaceutical used and the dose and route of administration, as well as any other pharmaceuticals administered, also with dose and route of administration.

VIII. RADIATION SAFETY

Radiologists, imaging technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as “as low as reasonably achievable (ALARA).”

Facilities, in consultation with the radiation safety officer, should have in place and should adhere to policies and procedures for the safe handling and administration of radiopharmaceuticals in accordance with ALARA, and must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by state and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol.

IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION

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 appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web page (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras.

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Suggested Reading (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

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*Guidelines and standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

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