NUCLEAR MEDICINE SERVICES

SUBJECT: PARATHYROID STUDY

Overview

Although Tc-99m sestamibi was developed as a myocardial perfusion agent, it also localizes in various tumors. Several studies have shown its ability to localize in parathyroid adenomas. (1-3) After IV injection, Tc-99m sestamibi appears to localize very rapidly (less than 5 minutes) in both parathyroid adenomas and thyroid tissue. Its washout from parathyroid adenomas appears to be slow, unlike from normal thyroid tissue, which is characterized by a relatively fast washout over 2-3 hours. The exact mechanism of Tc-99m sestamibi localization in tumors is not known, but it may be related to intracellular mitochondrial accumulation.

Indications

Parathyroid scintigraphy is indicated for the localization of parathyroid adenomas in patients with hyperparathyroidism. Excessive secretion of parathyroid hormone is generally caused by a solitary adenoma. (4) Scintigraphy is used to localize accurately the parathyroid lesions and is most helpful in patients who have undergone previous neck operations. (5) Normal parathyroid glands usually are not visualized because of their small size. Elevated serum calcium and parathyroid hormone. The images should be correlated with an ultrasound study of the thyroid/parathyroid glands.

Examination

Initially images (planar) 300sec/image at 15 minutes: ANT, LAO and RAO at 30 degrees

Delayed planar images 420sec/image (2 hr post injection): ANT, LAO and RAO at 30 degrees

Delayed SPECT or SPECT/CT images (2.5 hr post injection)
   **(SPECT/CT as ordered by physician or Radiologist request)
   **(Check Radiologist post 2hr planar images to receive instruction on SPECT/CT)

*Pre-op study protocol

**Initially images (planar) 300sec/image at 15 minutes
**Delayed Spect images taken 1-hour post injection for pre-op patients.
**Delayed planar images taken 1.5-hour post injection for pre-op patients.

Patient Preparation

None.

Equipment & Energy Windows

Gamma camera: Large field of view.
Collimator: LEHR Brightview XCT
Computer system: Matrix-planar images-128X128X16
Computer system con’t: Matrix-SPECT images-128X128
Processing requirements-SPECT reconstruction (AutoSpect)
Energy windows: 20 % at 140 KeV

Radiopharmaceutical, Dose, & Technique of Administration

99mTc Sestamibi: 20 mCi (925 MBq)
IV injection in vein or IV line

**Pediatric doses adjusted by weight.

Patient Position & Imaging Field
Patient position: Supine with head and neck extended and immobilized. Include orbits, neck and upper two thirds of the mediastinum.

**Acquisition Protocol**

15 minutes after injection
- Anterior, 30 degree RAO and 30 degree LAO view of the neck for 300 seconds
- SPECT images at 1 hour post images.
  1. Degrees of rotation: 360
  2. Number of images: 64
  3. Time per image: 30 seconds
  4. Matrix: 128X128

1.5 hour (pre-op) or 2 to 3 hours (out-patient)
- Anterior, 30 degree RAO and 30 degree LAO view of the neck for 420 seconds
- SPECT images at 3 hour post images. *(upon request)*
  5. Degrees of rotation: 360
  6. Number of images: 64
  7. Time per image: 30 seconds
  8. Matrix: 128X128

**Optional Maneuvers**

Dual isotope subtraction method:
Initial: I-123 500 uCi (18.5 MBq)
Three-four hours later: Tc-99-SESTAMIBI: 20 mCi (925 MBq)
I-123: Asymmetrical window from 153 - 175 keV.
Tc-99m-sestamibi: 14% window centered at 140 keV
Fifteen minutes after injecting the Tc-99m-sestamibi, acquire simultaneous I-123 and Tc-99m-sestamibi images with dual energy windows:
  a) Pinhole collimator: ANT, RAO, and LAO images of the neck for 10 minutes each (9).
  b) Parallel hole collimator: ANT image of neck and upper mediastinum for 10 minutes.
2. Normalize the thyroid counts in the I-123 image to the Tc-99m-sestamibi image for each pair of images.
3. Subtract the normalized I-123 image from the corresponding Tc-99m-sestamibi image

- **Parathyroid autografts:** May be evaluated for hyperfunction with the same technique
- **Intraoperative localization of parathyroid tissue:** A gamma probe may be used at the time of surgery with injection of Tc-99m-sestamibi 1 hour prior to surgery

**Interpretation:**

Parathyroid adenomas will appear as sestamibi-avid collections, which may be circular, oval, tubular or eccentric in shape. They can be located in extrathyroidal positions; superior, inferior, lateral or medial to the thyroid. They may also be located in the substernal or mediastinal region or anywhere from the salivary glands to the top of the heart. A parathyroid adenoma will appear as a small focal area of increased uptake on the 99mTc sestamibi images. If the parathyroid is located outside of the thyroid area, it can be seen as an area of focal increased uptake without the use of computer subtraction. However, if the parathyroid is in the thyroid bed, it may be necessary to subtract the thyroid tissue to visualize it, or it may be visualized on the delay images when thyroid activity has washed out. Interpretation may be more difficult in patients with multinodular goiters. In these patients, comparison with a pertechnetate or I-123 thyroid scan may be particularly important for proper interpretation. The I-123 thyroid scan allows for defining parathyroid adenomas or hyperplastic parathyroid glands in close proximity to the thyroid gland.

RADIATION DOSIMETRY

Principal Radiation Emission Data - Tc-99m

- Physical half-life = 6.01 hours.

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Mean % per disintegration</th>
<th>Mean energy (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gamma-2</td>
<td>89.07</td>
<td>140.5</td>
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</table>

Dosimetry - Tc-99m-Sestamibi (15)

<table>
<thead>
<tr>
<th>Organ</th>
<th>reds/25 mCi</th>
<th>mGy/925 MBq</th>
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<tbody>
<tr>
<td>Upper large intestine</td>
<td>3.88</td>
<td>38.8</td>
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<tr>
<td>Lower large intestine</td>
<td>2.68</td>
<td>26.8</td>
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<tr>
<td>Gallbladder wall</td>
<td>2.41</td>
<td>24.1</td>
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<tr>
<td>Small intestine</td>
<td>2.32</td>
<td>23.2</td>
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<tr>
<td>Kidneys</td>
<td>1.39</td>
<td>13.9</td>
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<tr>
<td>Urinary bladder wall</td>
<td>1.29</td>
<td>12.9</td>
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<tr>
<td>Ovaries</td>
<td>1.02</td>
<td>10.2</td>
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<tr>
<td>Thyroid</td>
<td>0.68</td>
<td>6.8</td>
</tr>
<tr>
<td>Red marrow</td>
<td>0.60</td>
<td>6.0</td>
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<tr>
<td>Whole body</td>
<td>0.38</td>
<td>3.8</td>
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<tr>
<td>Liver</td>
<td>0.36</td>
<td>3.6</td>
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<tr>
<td>Testes</td>
<td>0.24</td>
<td>2.4</td>
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Principal Radiation Emission Data - I-123 (16)

- Physical half-life = 13.2 hours.

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<tr>
<td>Gamma-2</td>
<td>83.3</td>
<td>159.0</td>
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<tr>
<td>Ce-K, gamma-2</td>
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<td>127.2</td>
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Dosimetry - I-123 as Sodium Iodine (17)

<table>
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<th>Organ</th>
<th>rads/500 µCi</th>
<th>mGy/18.5 MBq</th>
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<tbody>
<tr>
<td>Thyroid</td>
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<td>37.5</td>
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<td>Stomach wall</td>
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<td>1.2</td>
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<tr>
<td>Ovaries</td>
<td>0.02</td>
<td>0.2</td>
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<tr>
<td>Red marrow</td>
<td>0.02</td>
<td>0.2</td>
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<tr>
<td>Liver</td>
<td>0.01</td>
<td>0.1</td>
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<tr>
<td>Whole body</td>
<td>0.01</td>
<td>0.1</td>
</tr>
<tr>
<td>Testes</td>
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<td>0.1</td>
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References

Normal Findings


Overview

The Thyroid Imaging Study with radioiodine demonstrates the distribution of functioning thyroid tissue, including ectopic tissue, since thyroid tissue is the only tissue that concentrates large amounts of iodine.