PET SODIUM FLUORIDE BONE SCAN
(F-18 NaF)

Overview

- Sodium Fluoride F18 injection is a radioactive diagnostic agent for positron emission tomography (PET) indicated for imaging of bone to define areas of altered osteogenic activity.

Indication

- Identify skeletal metastasis, including localization and determination of extent of disease.
- Unexplained bone pain
- Osteomyelitis

Examination Time

- Allow approximately 2.5 hours for the entire PET/CT visit.
- Prior to Scan: Allow 30 minutes for interview, IV, and changing followed by 1 hour uptake post injection.
- Image acquisition:
  1. 78816 (full body – includes legs)
  2. 78815 (skull base to mid-thigh)
  3. 78614 (limited scan)

Patient Preparation

- No current reimbursement coverage
- Patient should hydrate with 2 glasses of water (8oz) one hour before examination
- Dress in comfortable clothing with no metal or jewelry

Diet

- No fasting – all medications are ok
Patient Interview and IV

- **Recent Surgery**
  - Record all surgeries. Be sure to note the date of all surgeries, including biopsies, within the last 6 months.

- **Chemotherapy**
  - Record dates and type, note if currently taking

- **Radiation Therapy**
  - Record dates and area

- **Infection**
  - Indicate any recent infections on the patient history.

**Sedations (oral)**

- Patients getting sedation must not take their own sedation medication within 4 hours prior to their arrival. Patients who do take their own medication will not be provided sedation by ARA.
- Sedation may be needed for claustrophobia. Alprazolam (Xanax) at 1 mg is commonly used to treat panic disorders including claustrophobia. These patients should arrive 1 hour prior to their injection. The paramedic will assess the patient and consult with the radiologist to determine the appropriate dosage.
- Patients requiring sedation must have a driver.

**Patient Uptake Phase**

1. The patient should lie still throughout the uptake period.
2. The patient should drink two 8oz glasses of water during uptake phase.

**Equipment & Energy Windows**

- Imaging system:
  - Siemens Biograph 16 PET-CT scanner.
  - GE Discovery ST PET-CT scanner.
- Collimators:
  - 3D mode (septa out or absent) (*Siemens Biograph 16 only has 3D function*)
  - 3D or 2D mode for GE Discovery ST depending on upgrade level.
- Energy windows (may vary with manufacturer and machine design): 30% window centered at 511 keV.
Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: F-18 Sodium Fluoride.

- Dosing:
  
  Average Adult: 10 mCi (370 MBq)
  
  Pediatric Patients: 0.06 mCi/kg – minimum 0.5 mCi
  
  Based on North American Consensus Guidelines for Radiopharmaceutical Activities in Children and Adolescents

- Technique of administration: Standard intravenous injection, contralateral to any site of concern, followed by saline flush

Patient Positioning & Imaging Field

- Patient position:
  1. Supine with a triangular bolster under the knees.
  2. Arms:
     ▪ At sides.
  3. Place Velcro strap around patient to assist patient in lying still.

- Imaging field of view: Usually from top of skull to bottom of feet
  ▪ The field of view may be top of skull to mid-femur
  ▪ Scan caudal-cranial to minimize bladder activity

Acquisition Protocol

- Approximately 45-60 minutes post injection, have the patient empty his/her bladder.

- Begin image acquisition approximately 60 minutes following injection of F-18 NaF.

- Have the patient empty his/her bladder after image acquisition. Give instructions to hydrate and void often.

- CT parameter values vary with patient size and machine specific factors:
  1. Kilovolts peak (kVp) guidelines:
     a) refer to pediatric protocols for all Pedi’s
     b) average adult: 120 kVp.
     c) obese adult: 140 kVp.
  2. Milliampere-seconds (mAs) guideline: Varies between approximately 200 and 400 mAs depending on patient size. Utilize care dose when indicated.
Data Processing

- The PET images are reconstructed using iterative reconstruction. Settings for the Siemens PET/CT scanner include: Matrix 180, 4 iterations, 10 subsets, Gaussian filter, filter FWHM 3.0, zoom 1.0. Settings for the GE Discovery ST PET/CT scanner include: 2D reconstruction, OSEM, 21 subsets, 2 iterations, 128 matrix, post filter 8.5, loop filter 5.47, diameter 70, center L 0, center P 0, z axis filter (yes), measured attenuation.

- Construct tomographic images with and without attenuation correction. In general, attenuation corrected images are used for primary interpretation and non-attenuation corrected images may be used in problem solving.

- A rotating maximum intensity projection (MIP) display facilitates lesion detection.

- Create Coronal CT reformation as well as axial soft tissue and bone recons.

Optional Maneuvers

- Oral administration of F-18 NaF: In patients without intravenous access, the radiopharmaceutical may be given orally.

Principle Radiation Emission Data - F-18

- Physical half-life = 109.8 minutes.

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Mean % per disintegration</th>
<th>Mean energy (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positron</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Gamma ±</td>
<td>200</td>
<td>511</td>
</tr>
</tbody>
</table>

Radiation Dosimetry

The age/weight- based estimated absorbed radiation doses (mGy/MBq) from intravenous injection of Sodium Fluoride F 18 Injection are shown in Table 1. These estimates were calculated based on human data and using the data published by the Nuclear Regulatory Commission [1] and the International Commission on Radiological Protection for Sodium Fluoride Injection [2]. The bone, bone marrow and urinary bladder are considered target and critical organs.
Table 1: Estimated Absorbed Radiation Doses after Intravenous Administration of Sodium Fluoride F 18 Injection

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Adrenals</td>
<td></td>
<td>0.0062</td>
<td>0.012</td>
<td>0.018</td>
<td>0.028</td>
<td>0.052</td>
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<tr>
<td>Brain</td>
<td></td>
<td>0.0056</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Bone surfaces</td>
<td></td>
<td>0.060</td>
<td>0.050</td>
<td>0.079</td>
<td>0.13</td>
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<tr>
<td>Breasts</td>
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<td>0.0028</td>
<td>0.0061</td>
<td>0.0097</td>
<td>0.015</td>
<td>0.030</td>
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<tr>
<td>GI Gallbladder wall</td>
<td></td>
<td>0.0044</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Stomach wall</td>
<td></td>
<td>0.0038</td>
<td>0.008</td>
<td>0.013</td>
<td>0.019</td>
<td>0.036</td>
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<tr>
<td>Small intestine</td>
<td></td>
<td>0.0066</td>
<td>0.012</td>
<td>0.018</td>
<td>0.028</td>
<td>0.052</td>
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<tr>
<td>Upper large intestine wall</td>
<td></td>
<td>0.0058</td>
<td>0.010</td>
<td>0.016</td>
<td>0.026</td>
<td>0.046</td>
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<tr>
<td>Lower large intestine wall</td>
<td></td>
<td>0.012</td>
<td>0.016</td>
<td>0.025</td>
<td>0.037</td>
<td>0.063</td>
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<tr>
<td>Heart wall</td>
<td></td>
<td>0.0039</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Kidneys</td>
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<td>0.019</td>
<td>0.025</td>
<td>0.036</td>
<td>0.053</td>
<td>0.097</td>
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<tr>
<td>Liver</td>
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<td>0.0040</td>
<td>0.0084</td>
<td>0.013</td>
<td>0.021</td>
<td>0.039</td>
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<tr>
<td>Lungs</td>
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<td>0.0041</td>
<td>0.0084</td>
<td>0.013</td>
<td>0.020</td>
<td>0.039</td>
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<tr>
<td>Muscle</td>
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<td>0.0060</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Ovaries</td>
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<td>0.011</td>
<td>0.016</td>
<td>0.023</td>
<td>0.036</td>
<td>0.063</td>
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<td>Pancreas</td>
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<td>0.0048</td>
<td>0.0096</td>
<td>0.015</td>
<td>0.023</td>
<td>0.044</td>
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<td>Red marrow</td>
<td></td>
<td>0.028</td>
<td>0.053</td>
<td>0.088</td>
<td>0.18</td>
<td>0.38</td>
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<tr>
<td>Skin</td>
<td></td>
<td>0.0040</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Spleen</td>
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<td>0.0042</td>
<td>0.0088</td>
<td>0.014</td>
<td>0.021</td>
<td>0.041</td>
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<tr>
<td>Testes</td>
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<td>0.0078</td>
<td>0.013</td>
<td>0.021</td>
<td>0.033</td>
<td>0.062</td>
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<tr>
<td>Thymus</td>
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<td>0.0035</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Thyroid</td>
<td></td>
<td>0.0044</td>
<td>0.0084</td>
<td>0.013</td>
<td>0.020</td>
<td>0.036</td>
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<tr>
<td>Urinary bladder wall</td>
<td></td>
<td>0.25</td>
<td>0.27</td>
<td>0.4</td>
<td>0.61</td>
<td>1.1</td>
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<tr>
<td>Uterus</td>
<td></td>
<td>0.019</td>
<td>0.023</td>
<td>0.037</td>
<td>0.057</td>
<td>0.099</td>
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<tr>
<td>Other tissue</td>
<td></td>
<td>N/A</td>
<td>0.010</td>
<td>0.015</td>
<td>0.024</td>
<td>0.044</td>
</tr>
<tr>
<td>Effective Dose Equivalent mSv/MBq</td>
<td></td>
<td>0.027</td>
<td>0.034</td>
<td>0.052</td>
<td>0.086</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Dosimetry - Computed Tomography

- Actual effective doses will depend on the user-specific exam protocol and the specific CT scanner used. Care dose should be used when indicated.

<table>
<thead>
<tr>
<th>Effective dose</th>
<th>rem</th>
<th>mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic CT</td>
<td>1.9</td>
<td>19.0</td>
</tr>
<tr>
<td>Low dose CT</td>
<td>0.3</td>
<td>3.0</td>
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</table>