18-F-FDG PET/CT TUMOR IMAGING

Radiology Associates of Clearwater

INDICATIONS:

a. Differentiation of benign from malignant lesions (1, 2, 3, 4).

b. Staging of malignant disease (4, 5, 6).

c. Grading of malignant brain lesions (1, 2).

d. Differentiation of recurrent malignant diseases from therapy-induced changes (7, 8, 9).

e. Monitoring response to therapy (10).

f. Evaluation of dementia.

PATIENT PREPARATION & SCHEDULING:

a. Determine the primary indication and assure it is an approved indication.

b. The patient is to be called by a nurse or technologist, and the test explained prior to the scheduled date. Begin filling out the history sheet.

PATIENT INSTRUCTIONS

ASK THE FOLLOWING QUESTIONS:

Ask if the patient is claustrophobic and is able to lie absolutely still for approximately 30 min. or does the patient need to be sedated.

Ask if the patient can hold their arms over their head.

Ask if the patient is diabetic or had borderline blood sugar problems. If so, the patient should take no insulin the morning of the exam and should be scheduled first in the am.

Ask if there has had recent surgery in the last 6 months, recent chemotherapy, radiation therapy or diagnostic procedures. Get the dates if possible.
If the patient is of childbearing age, ask if she may be pregnant. If the patient is not sure, she needs to have a BHCG done prior to the scan, unless she has had a hysterectomy with documentation.

TELL THE PATIENT THE FOLLOWING INFORMATION: Refer to patient prep sheet.

1. The patient needs to avoid vigorous exercise on the day before and on the day of the exam.

2. Patient needs to be NPO except for water for at least 6 hours prior to scan. Emphasize that No gum, candy, soda, coffee etc is to be used 6 hours prior to the exam. A low carbohydrate diet in the morning is OK (toast and a cup of orange juice or milk) if having an afternoon scan.

3. Patient also needs to be hydrated prior to scan. Drink 2 glasses of water (8 oz), one each hour prior to scan.

4. Patient will arrive in the department and will have an I.V. inserted for injection of the radiopharmaceutical. Blood from the IV insertion will be used to check a glucose level. (High glucose level can severely effect myocardial uptake of $^{18}$F-FDG and severely degrade the quality of the $^{18}$F-FDG images). The patient may also be catheterized if examining the lower abdomen.

5. Usual time in the department is 2 hours.

6. For all exams, the patient will be given oral contrast upon arrival to the department, unless the patient has an allergy to iodine. Oral contrast is not required for cardiac exams, brain studies and head/neck cancer.

7. Advise the patient to not wear jewelry that could be in the field of view.

EXAMINATION TIME:
Total of 2 hours: 1 hour waiting period after $^{18}$F-FDG injection, 30min of imaging time.

RADIOPHARMACEUTICAL:

$^{18}$Fluoro-2-deoxyglucose ($^{18}$F-FDG), 15mCi ** (Non-brain studies).
** The Dose of 18F-FDG is 10mCi for the Carlisle PET/CT scanner**

18F-FDG, 10mCi for Brain studies.

**METHOD OF ADMINISTRATION**

Intravenously at a site contralateral to the site of concern.

Patient should be relaxed for injection. Patient should be resting comfortably for the uptake portion of 18F-FDG (minimum 60 minutes for tumor imaging and 30 minutes for brain imaging), preferably for the entire time, post injection to scanning.

**EQUIPMENT:**

PET/CT scanner

**PROCEDURE:**

**NOTE:** Assigned technologist for 18F-FDG imaging must stay with the patient throughout the acquisition and remind the patient not to move during acquisition

1. On the morning of the study review the patients history and record on history sheet. The patient’s blood glucose level will be checked prior to injecting 18F-FDG. The patient’s blood glucose level reading will be obtained and recorded on the patient’s worksheet by the technologist (Glucose levels between 60 and 200 mg/dl are acceptable for brain and tumor imaging.) If this is not the case, notify the Nuclear Medicine physician of the blood glucose level result and DO NOT inject the 18F-FDG until further instruction from Nuclear Medicine physician.

2. Oral contrast will be used when evaluating all cancers with the exception of cardiac, brain and head/neck exams. See oral contrast guidelines at the end of this protocol.

3. Inject 18F-FDG intravenously after establishing an IV line.

4. For brain imaging, the patient will be injected with 18F-FDG in a quiet and dimly lit room with the eyes covered and will stay in the room until imaging time. (See brain protocol)

5. After the injection of 18F-FDG, the patient must remain in the Nuclear Medicine Clinic holding room.
6. After a **60min wait** (30minutes for brain imaging), have patient void prior to imaging.

7. Head and neck tumor patient evaluations must refrain from talking or exercising neck muscles.

8. If the patient cannot raise his/her arms above the head, arms must be strapped tightly to his/her torso for imaging.

9. Positioning is as follows:

   Be sure to have the proper items on the table prior to patient exam (i.e.: head rest or table extension) (see Positioning protocols below)

   - Have all metal items removed from the patient (i.e.: glasses, underwire bras, keys, change, wallet, belt buckle, pens, clips, and if for head and neck cancers in the area of the mouth, have patient remove false teeth)

   - Have patient lie on the table and make them comfortable (i.e.: blanket, wedge under knees, ect…)

   - If patient has zipper and buttons on pants, have them lower their pants down below mid thigh.

   - Explain to patient what is expected of them and also let them know what will be happening as soon as the exam is started.

   - Use inner lasers to land mark patient for start of exam.

From acquisition screen:

1. On C.T. screen (monitor #1) click on [New Patient]

2. Type in Medical Record number, Name, DOB, Ht, Wt.

3. Select Protocol for patient study

4. Scout image is performed 1\textsuperscript{st} at 120 kv, 10 mA

5. C.T. imaging is performed 2\textsuperscript{nd} at 140 kv, 120 mA (100-200 lbs)(normal)

6. C.T. imaging is performed 2\textsuperscript{nd} at 140 kv, 200 mA (200-400 lbs)(large)

7. P.E.T. imaging is performed 3\textsuperscript{rd} at 3 minute F.O.V. (100-200 lbs)(normal)
8. P.E.T. imaging is performed 3rd at 5 minute F.O.V. (200-400 lbs)(large)
9. C.T. imaging lower extremities at 140 kv, 80 mA.
10. P.E.T. imaging lower extremities at 2 minutes F.O.V.
11. C.T. imaging brain at 140 kv, 80 mA.
12. P.E.T. imaging brain 3D at 8 minutes F.O.V.

Imaging Protocols based on tumor type:

- SPN: head in, arms up, base of skull to mid-thigh
- Lung CA: head in, arms up, base of skull to mid-thigh
- Colon CA: head in, arms up, base of skull to mid-thigh
- Lymphoma: head in, arms up, base of skull to mid-thigh
- Breast CA: head in, arms up, base of skull to mid-thigh
- Esophageal: head in, arms up, base of skull to mid-thigh
- Melanoma: head in, arms down, top of head to feet
  * For Ocular Melanoma scan with arms up*
- Head & Neck: head in, arms down, use head holder, base of skull to mid-thigh
- Thyroid CA: head in, arms down, use head holder, base of skull to mid-thigh
- Seizures: head in, arms down, entire head, use head holder, 3D
- Myocardial Viability: head in, arms up.
- Dementia: head in, arms down, entire head, use head holder 3D
COMPUTER PROCESSING AND DISPLAY:

RECON
Matrix – 128 x 128  Diameter – 70.0 cm
Recon Method – Iterative  Center L – 0.0 cm
Subsets – 30  Center P – 0.0 cm
Iterations – 2
Z-axis filter – Standard
Post filter – 6.00 (FWHM)

ATTENUATION
Type – Measured  Transmission Scan - Most recent

CORRECTIONS
Well Counter File – Default  Normalization – Default
Well Counter – Sensitivity and Activity  Randoms – Correction by
Singles
Decay – Yes  Deadtime – Yes  Scatter – Yes

After acquisition completes normally, select the SCREENS icon located on top of left monitor and choose quit screens. Next, on the right monitor select the EXAM RX icon, located near the top of the monitor and choose the END EXAM icon on left monitor, located near the bottom of the screen. On the right monitor choose the IMAGE WORKS icon, located in the column located near the top of the monitor. Select a patient and highlight the CT SLICES group and WB 3D AC group. Now select the IMAGE QC icon located in the column on the right side of the right monitor. This will bring up views of the coronal, sagittal, and axial fused datasets. This will also bring up a 3D PET only image. Under the CONSOLE QC1, move the cursor on the PET image into the liver and then the lung. The volume number should be 1.5-3.0 in the liver and < 1.0 in the lung. If the numbers are outside this range, check to make sure the dose, height, and weight are recorded in the study. This information is used to create the correct SUV or volume values. Review the fused axial dataset for motion. If necessary review motion with the physician to decide if additional imaging is necessary. Close the exam. Send the SCOUT, CT SLICES, WB 3D AC, WB 3D NAC, FUSED CORONAL, FUSED SAGITTAL, FUSED AXIAL, MIP and all paperwork to the PACS system. Send the CT SLICES, WB 3D AC, and WB 3D NAC to the physician’s reading station.

DOSIMETRY - $^{18}$F-FDG (14):

a. Adult: The critical organ is bladder receiving 0.63 rads per 10 - 20 mCi dose

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Administered Activity</th>
<th>Organ Receiving the Largest Radiation Dose*</th>
<th>Effective Dose*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MBq (mCi)</td>
<td>mGy (rad)</td>
<td>mSv (rem)</td>
</tr>
<tr>
<td>18-fluoro-2-deoxyglucose (FDG)</td>
<td>350 – 750 i.v. (10 – 20)</td>
<td>0.17 bladder (0.63)</td>
<td>0.027 (0.10)</td>
</tr>
</tbody>
</table>

*Per MBq (per mCi)
1 ICRP 53, page 76
b. Children (5 years old): The critical organ is bladder receiving 1.8 rads per 0.15 -0.30 mCi/kg dose.

<table>
<thead>
<tr>
<th>Radiopharmaceutical</th>
<th>Administered Activity MBq/kg (mCi/kg)</th>
<th>Organ Receiving the Largest Radiation Dose* mGy (rad)</th>
<th>Effective Dose* mSv (rem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-fluoro-2-deoxyglucose (FDG)</td>
<td>5 – 10 i.v. (0.15 – 0.30)</td>
<td>0.48 bladder (1.8)</td>
<td>0.073 (0.27)</td>
</tr>
</tbody>
</table>

*Per MBq (per mCi)
†ICRP 53, page 76

REFERENCES:


**Oral Contrast Protocol for PET/CT**

1. Prepare contrast by mixing 10ml of gastrografin in 1L of water with crystal light lemonade mix.

2. Give the patient 1/3 of the contrast upon arrival.

3. Give the next 1/3 20 minutes after injecting FDG.

4. Give the final 1/3 just prior to imaging.
**If the patient is unable to tolerate oral contrast, give at least glasses of water prior to scanning**