18F-FDG & 99mTc TETRAFOSMIN MYOCARDIAL SPECT IMAGING

Radiology Associates of Clearwater

PURPOSE:
The purpose of this SOP is to outline performing, interpreting, and reporting the results of 18fluoro-2-deoxyglucose (18F-FDG) PET and Tc99m Tetrafosmin SPECT imaging in the evaluation of patients with known coronary artery disease. (Details at back of SOP).

INDICATIONS:
Differentiation of scarred myocardium from hibernating myocardium.
Differentiation of scarred myocardium from stunned myocardium.
Assess the viability of myocardium for further invasive cardiac interventions.

PATIENT PREPARATION & SCHEDULING:

ASK THE FOLLOWING QUESTIONS:
Ask if the patient is claustrophobic and is able to lie absolutely still for approximately 30 min for two separate exams or does 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 the patient is of childbearing age, and possibly pregnant, a serum b-HCG will be performed prior to the exam.

TELL THE PATIENT THE FOLLOWING INFORMATION:
1. The patient needs to avoid vigorous exercise on the day before and on the day of the exam.
2. The patient needs to be NPO except for water for at least 4 hours prior to scan. No gum, candy, soda, etc. Can have a light breakfast if having an afternoon exam.
   - Diabetic patients should take their insulin or hypoglycemic oral medication at the usual time. NOTE: The patient should carry sugar with them at all times in the event they have a hypoglycemic reaction.
3. Patient also need to be hydrated prior to scan. For in-patients, use I.V. normal saline. For outpatients, 4 to 6 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 radiopharmaceutical injection. Blood from the IV insertion will be used to check a glucose level. (High glucose level can severely effect myocardial uptake of 18F-FDG and severely degrade the quality of the 18F-FDG images). Two separate injections will be done through their I.V. line with two separate scans. One will be for
the resting gated $^{99m}\text{Tc}$ Tetrafosmin images and the other will be for the $^{18}\text{F}$-FDG images.

5. Usual time in the department is around 4 hours.

EXAMINATION TIME:
Around 4 hours: 1.5 hours for the $^{99m}\text{Tc}$ Tetrafosmin rest Gated SPECT study. 1 - 2 hour waiting period after glucose loading. 1 hour $^{18}\text{F}$-FDG study. The rest SPECT images may be performed on the same day or a separate day than the PET imaging depending on the schedule.

RADIOPHARMACEUTICAL & PHARMACEUTICALS:

- $^{18}\text{F}$-fluoro-2-deoxyglucose ($^{18}\text{F}$-FDG). 10.0 mCi IV.
- $^{99m}\text{Tc}$ Tetrafosmin, 22.0 mCi IV.
- 50 – 100 gm orange glucose liquid (for non-diabetic patient).
- Regular human insulin. (Drawn by physician, RN, or pharmacist – 2 people need to verify the dose).
- D5W IV ready for setup and infusion. This is in case there is an insulin reaction.(D50 ampules are in the radiopharmacy for further dilution).

METHOD OF ADMINISTRATION:

$^{99m}\text{Tc}$ Tetrafosmin:
Patient should be relaxed and supine for injection. An IV will be inserted. The $^{99m}\text{Tc}$ Tetrafosmin is injected IV and the patient is scanned 30 minutes later.

$^{18}\text{F}$-FDG:
1. Patient should be relaxed and supine for injection. Patient should be supine and resting for uptake portion of $^{18}\text{F}$-FDG (minimum 30 minutes), preferably for the entire time, post injection to scanning.
2. A 10cc syringe will be QS to 5cc with a 23-gage butterfly needle attached. This will be placed in a leaded box. Patient will be injected IV.

PROCEDURE:
1. Upon patient arrival into the department:
   A. Explain procedure to the patient.
      1. Check to ensure patient has had nothing to eat, suck, or chew on except water in the within 4hrs of the scheduled FDG injection time.
      2. Check with patient as to whether their meds were taken today and obtain a list of these meds as well as a 48 hour BS history on diabetic patients.
   B. Start an IV of 0.9% NaCl at approx 120 cc/hr.
   C. Obtain a Blood Sugar (BS) and record results on the flowsheet (recommended level = 120 mg/dl, but must be less than 160 mg/dl).
   D. inform physician/radiologist of patient's arrival and BS results and await further continuation instructions.
CAUTION:
Hypoglycemia is due to a low blood sugar, usually caused by being given too much insulin, excessive release of insulin by the pancreas, or low food intake. The condition may result in weakness, headache, hunger, problems with vision, loss of muscle coordination, anxiety, personality changes, and, if untreated, delirium, coma, and death. The treatment is the administration of sugar by mouth if the person is conscious or through the veins if the person is unconscious. Contact our physician or RN immediately if glucose level is < 60 gm/dL.

****IF INSULIN IS ADMINISTERED PRIOR TO OR AFTER TETRAFOSMIN INJECTION, ENSURE PATIENT IS HOLDING CUP WITH GLUCOSE SOLUTION IN THEIR HAND FROM THIS POINT ON AND OBTAIN BLOOD SUGAR LEVELS AT 30 MINUTE INTERVALS.

2. Inject patient with 20mCi Tc Tetrafosmin and perform a GATED SPECT attenuation corrected imaging session with collimators normally utilized for Tc99m cardiac imaging. Process immediately following acquisition and show to the nuclear medicine physician.

3. When Tetrafosmin imaging is complete, prepare the patient for FDG-PET imaging.

****DO NOT CONTINUE UNTIL THE PATIENT'S DOSE OF FDG HAS ARRIVED****

4. The BS level for FDG cardiac imaging needs to be between 120 to160 mg/dl. Depending on the patient's blood sugar level, the following will be performed:
   A. Glucose Loading--if glucose loading is necessary, the physician will direct the amount to administer, usually this is 50-90 gm. Wait approximately 45min and retest BS level.
   B. Insulin IV--the nurse will administer regular IV insulin according to the following sliding scale:
      1. Less than 120 mg/dl = no insulin
      2. 120 - 150 mg/dl = 2-3 units of regular insulin.
         Check BS 30 minutes later.
      3. 150 - 200 mg/dl = 3-5 units of regular insulin.
         Check BS 30 minutes later.
      4. 200 - 250 mg/dl = 5-7 units of regular insulin.
         Check BS 30 minutes later.

5. Once the physician approves FDG injection at the appropriate level, inject the patient with 10mCi $^{18}$F-FDG. Physician or RN will administer 2-5 units of regular insulin IV at the time of the FDG administration. Check BS at 30 min intervals or sooner if requested. (Order 15mCi FDG to anticipate delays in injection due to glucose levels not within the established range).
6. Position the patient on the scanner 30 minutes after FDG injection. Acquire a one bed position scan in 2D mode over the heart.

7. Upon completion of the exam and before the patient leaves the department:
   A. Check and document blood sugar. If blood sugar is <60, give one bottle of orange juice and recheck in 10 minutes. Encourage the patient to eat as soon as possible.
   B. Process the FDG scan.

   NOTE: This information should be used as a guideline rather than a fixed prescription for every patient. Patients may require less insulin, particularly if they are small and/or take regular/long acting insulin subcutaneously as part of their daily regimen.

COMPUTER PROCESSING AND DISPLAY:
   Process the $^{99m}$Tc Myoview and FDG PET study together using the myovation program.
   Process the $^{18}$F-FDG using the Xeleris station and reconstruct into SA, HLA, VLA slices for comparison with the Myoview exam.
   Print images x2 on the Codonics printer.

INTERPRETATION AND REPORTING:
   Normal physiologic uptake of $^{18}$F-FDG can be seen in the brain, myocardium, liver, spleen, stomach, intestine, kidneys and urine.
   Increased uptake of $^{18}$F-FDG can be seen in tumor sites, healing surgical wounds, granulomatous tissue, infections and other inflammatory-type tissue.
   Quantitative and semiquantitative estimates may be helpful in identifying malignant lesions.

SOURCES OF ERROR (15):
   a. Residual bowel and/or urinary tract activity may cause both false-positive and false-negative abdominal examinations.
   b. Local inflammatory disease may cause increased $^{18}$F-FDG uptake, especially granulomatous process.
   c. Chemotherapy and radiation therapy may decrease tumor uptake of $^{18}$F-FDG.
   d. Physiologic uptake of $^{18}$F-FDG may be seen in the thymus, especially in younger patients.
   e. Increased $^{18}$F-FDG uptake in the pulmonary parenchyma can be seen in radiation pneumonitis and in the pleura after radiation therapy.
   f. Physiologic uptake of $^{18}$F-FDG may occur in the paraspinal muscles and in other skeletal muscles.
   g. Images reconstructed without attenuation correction have the appearance of prominent peripheral body or skin activity.
h. Healing surgical wounds may have increased $^{18}$F-FDG activity up to 6 months after surgery.

i. High glucose level may give false negative. This is because a high blood glucose level can cause less uptake of $^{18}$F-FDG in cardiac.

**PRINCIPLE RADIATION EMISSION DATA:**

- a. $^{99m}$Tc Tetrafosmin – Physical T1/2 = 6 hr / Energy = 140 keV.
- b. $^{18}$F-FDG - Physical T1/2 = 110 minutes / Energy = 511 keV.

**DOSIMETRY:**

- a. $^{99m}$Tc Sestamibi:
  - Adult: The critical organ is upper large intestine wall receiving 5.4 rads per 30mCi.
- b. $^{18}$F-FDG (16):
  - Adult: The critical organ is bladder receiving 0.63 rads per 10 - 20 mCi dose. Adult average: 0.11 rem/mCi.; Average $^{18}$F-FDG scan (495 mrem) = ~ one CT scan.

Children (5 years old): The critical organ is bladder receiving 1.8 rads per 0.15 -0.30 mCi/kg dose.

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<thead>
<tr>
<th>TERM</th>
<th>Definition</th>
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<tr>
<td>Ischemic myocardium</td>
<td>O₂ deprivation and inadequate waste removal due to reduced perfusion.</td>
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<tr>
<td>Infarcted myocardium</td>
<td>Irreversible myocardial damage with histologic formation of scar.</td>
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<tr>
<td>Hibernating myocardium</td>
<td>Viable myocardium with impaired function due to reduced perfusion</td>
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<tr>
<td>Stunned myocardium</td>
<td>Myocardium with contractile dysfunction despite normalization of perfusion</td>
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Combined Perfusion and PET FDG Imaging Diagnostic Patterns

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<tr>
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<th>99m Tc Sestamibi</th>
<th>Glucose Metabolism (18F-FDG)</th>
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<tr>
<td>Normal myocardium</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ischemic myocardum</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>(chronic, severe)</td>
<td></td>
<td></td>
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<tr>
<td>Necrotic myocardum</td>
<td>-</td>
<td>-</td>
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<tr>
<td>or scar</td>
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REFERENCES:


14. SMV Operators Manual


JSM- FDG Myocardial Viability
Rev. 3/30/15