



FDG PET VIABILITY IMAGING PROTOCOL

1) Patient preparation:

- Patients must fast 6 – 12 hours. (**ASNC – 6-12 hours**)
- Hold diuretics (easier for patient to tolerate time in scanner).
- If fasting overnight, hold oral diabetic medications/insulin.
- Schedule diabetic patients in the morning (preferred). If diabetic patient is scheduled for afternoon, patient may have light breakfast and medications as required.
- Weight limit of camera 500 lbs.
- Patient should void before the PET scan.
- Female patients of childbearing potential (up to 55 yrs). Proceed with urine pregnancy test.

2) Patient positioning:

- Arms-up (above head) out of the cardiac FOV produces the best image quality.
- Arms-down only in occasional patients who cannot tolerate arms-up position.
- Scout scan to confirm heart is centered in the FOV. Landmark at xyphoid process.
- Patient orientation: head first.
- Patient position: supine.
- kV 120, mA 10.

3) CT Attenuation Correction Scan (CTAC):

- Low dose X-ray CT (< 1 mSv).
- Fast helical scan (<0.4s) at normal mid-to-end expiration.
- Smart mA - Automatic Exposure Control – combines both z axis and angular tube current modulation to

adjust the dose to the size and shape of individual patients – accounting for all three dimensions. Prior to scanning, the user selects the desired image quality, or noise index. Based on a single scout scan, the system adjusts the exposure during the CT scan to achieve that level of acceptable noise across the region of interest. The system increases and decreases the mA as it encounters various anatomy thicknesses and asymmetries. Compared with using fixed mA, Smart mA can reduce patient dose by as much as 32.5% while maintaining consistent image quality.

- Reference noise index: 12.35 (dose steps: -60.97, noise index: 50).
- mA range 20 – 210, kV 140.
- Scan type – helical, Rotation time – 0.4 sec, Rotation length – full, Detector coverage – 40 mm, Helical thickness – 3.75 mm, Coverage speed – 98.42 mm/sec, Coverage time – 2.0 sec, Interval – 3.27 mm, SFOV – large body, Pitch & Speed (mm/rot) – 0.984:139.37, DFOV – 70 mm, Recon type – std wide view, Matrix size 512, Recon mode – full, Window width – 400, Window level – 40, Cardiac filter – none, Number of images 47.

4) Rest Perfusion Scan:

- Resting perfusion scan must be performed prior to FDG imaging if scan is on the same day as FDG. If scan is performed on separate day, it must be within 2 weeks of FDG scan if the patient is stable. (Unstable patients, resting scan must be done on the same day as FDG imaging).
- See Rb or NH3 imaging protocol (rest scan only).

- Rb image must be assessed, if poor quality, proceed directly with rest NH3 scan.
- Rb dose increased to 15 MBq/kg. Scanning time for Rb increased to 11 min. (**ASNC – 740 MBq Rb and bolus injection <= 30 seconds**).
- **Static image:** Prescan delay 3 min 30 sec, Scan time 7 min 30 sec.
- **ASNC – 3-6 minutes standard; 3-10minutes optional.**
- **Gated image:** Prescan delay 3 min, Scan time 8 min.
- **Dynamic image:** Prescan delay 0 min, Scan time 10 min, Number of phases 5.
- Frame times: 9x10s, 3x30s, 1x60s, 1x120s, 1x240s.

5) **FDG Injection:**

- Dose: 5 MBq/kg for 3D or 2D (< 555 MBq (15 mCi) maximum). (**ASNC – 185 – 555 MBq**)
- Check blood pressure and heart rate pre and post FDG injection.
- Follow oral glucose load (non-diabetics) or glucose-insulin clamp (diabetics).
- Static/Gated imaging 45 – 60 minutes post FDG injection for optimal myocardial uptake. (**ASNC – 45 – 60 minutes post FDG injection**).

6) **FDG Static/Gated Scan Acquisition:**

- Static/Gated scan duration 20 minutes. (**ASNC – 10 – 30 minutes depending on count rate and dose**).
- Start time: 45 – 60 minutes post FDG injection.

7) **FDG Dynamic Scan Acquisition:**

- Start time: at start of FDG injection.

- Scan time 70 minutes. Check quality of image, if quality poor, remove patient from scanner and re-image in 20 - 30 minutes.

8) **PET Recon/Replay (Static/Gated):**

- **Static image:** Prescan delay 0 min, Scan time 20 min, Number of phases 1, Number of images 47.
- **Gated image:** Prescan delay 0 min, Scan time 20 min, Number of phases 1, Number of images 376.
- Gated binning mode: Binning type – percent, Trigger rejection – cycle rejection + next, Pre-phase delay (ms) – 0, Number of bins – 8, 12.5% per bin, Percent per phase – 100, Ave. trig/min 80; Percent deviation allowed 50 (HR range 120-40) * May have to change according to patients HR.
- Scan direction – towards feet.
- Number of bed positions 1.
- DFOV 50 cm (static, gated).
- R/L centre (mm) R 0.0, A/P centre (mm) A 0.0 (static, gated).
- Matrix size 128 x 128.
- **Recon Option:** (static, gated, dynamic), Attenuation type: measured, CTAC type – image set, CTAC series – CT std, Contrast compensation – automatic, Correction: Well counter – sensitivity and activity (WCC file: default), Normalization – default, Randoms – singles, Scatter – ON (scatter correction mandatory for 3D systems due to high scatter fraction (45% quoted, probably 60 % in patients)), Deadtime: ON, DMPR – N (static, gated).

9) **Reconstruction Type (Static, Gated):**

- **VPMX (Time of Flight):** turned off until problems resolved. Will be done in the future.
- **Static # 1:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 10 mm, subsets 24, iterations 4, cardiac 3D - on, Z axis filter – none.
- **Static # 2:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 13.5 mm.
- **Static # 3:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 12 mm.
- **ASNC – FBP or iterative expectation max (OSEM) and recon pixel size 2-3mm preferred; 4-5mm acceptable.**
- **Gated:** Recon method: VUE Point HD, Filter type: Hanning with filter cutoff 4 mm and 8 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none.

10) Pet Recon/Replay (Dynamic):

- **Static image:** Prescan delay 40 min, Scan time 30 min, Number of phases 1, Number of images 47.
- **Gated image:** Prescan delay 40 min, Scan time 30 min, Number of phases 1, Number of images 376.
- **Gated binning mode:** Binning type – percent, Trigger rejection – cycle rejection + next, Pre-phase delay (ms) – 0, Number of bins – 8, 12.5% per bin, Percent per phase – 100, Ave. trig/min 80; Percent deviation allowed 50 (HR range 120-40) * May have to change according to patients HR.
- **Dynamic image:** Prescan delay 0 min, Scan time 70 min, Number of phases 4, Number of images 1269.
- **Frame times:** 9x10s, 3x30s, 2x60s, 13x300s.
- **Scan direction – towards feet.**
- **Number of bed positions 1.**
- **DFOV 50 cm**
- **R/L centre (mm) R 0.0, A/P centre (mm) A 0.0.**

- Matrix size 128 x 128.
- **Recon Option:** same as static/gated.

11) Reconstruction Type:

- **Static image #1,2,3:** same as static/gated.
- **Gated image:** same as static/gated.
- **Dynamic image:** Recon method: FORE – FBP, Filter type: Hanning with filter cutoff 8 mm, subsets 24, iterations 4, cardiac 3D – on, Z axis filter – none.

12) QA review:

- Assess FDG image quality. If poor quality, remove patient from scanner and repeat scan in 20 – 30 minutes. Patient may eat at this time. If image quality fair, repeat scan immediately with another 20 minute FDG scan without removing patient from scanner.
- CTAC alignment – shift as needed.
- Use static image with iterative reconstruction (8 mm) with CT std.

PROTOCOL FOR BLOOD GLUCOSE MANAGEMENT IN NON DIABETIC PATIENTS UNDERGOING MYOCARDIAL TISSUE VIABILITY STUDIES WITH FDG PET

1) Oral Glucose Load Protocol:

- Non-diabetic OR diabetic patients – complete corresponding data sheets.

2) Procedure:

- Patients are to be fasting 6 – 12 hrs (preferred) or a minimum of 6 hrs. (**ASNC – 6-12 hours preferred/<6hours suboptimal**).
- Schedule diabetic patients in the morning (preferred). If diabetic patient fasting overnight, hold oral diabetic medications/insulin. **At UOHI insulin/glucose clamp protocol used for diabetic patients ONLY; avoid using oral glucose load.**
- Hold diuretics (easier for patient to tolerate time in scanner).
- Resting perfusion scan must be performed prior to FDG imaging if scan is on the same day as FDG. If scan is performed on separate day, it must be within 2 weeks of FDG scan (if patient stable, unstable patients resting scan must be on same day as FDG imaging).
- Check Plasma Glucose Level (PGL) on glucometer (when drawing blood from IV use 1 cc TB syringe and discard 0.3 cc blood before checking the PGL. Remember to flush lock afterwards). Baseline potassium, glucose, creatinine blood tube drawn. (needed if supplemental insulin given).
- If PGL is < 5mmol/L **give 50g of Glucola**
- If PGL is 5.1 – 6.9 mmol/L **give 25g Glucola**

- If PGL is 7 – 10 mmol/L **give 25g of Glucola and 5U regular insulin (at UOHI we give 1 – 2U of insulin, with 5U insulin patients became hypoglycemic) OR (We have patients walk (if able) to help decrease blood glucose levels). Check PGL in 20 minutes.**
- If PGL is > 10 mmol/L **notify MD. May decide to order larger dose of insulin or switch to insulin/glucose clamp protocol.**
- Each bottle of Glucola has 75 g in 300 cc.
- **ASNC – fasting blood glucose, BG < 13.9 mmol/L, then give 25-100g oral glucose. Monitor the BG. If fasting BG>13.9mmol/L, then follow the ASNC guideline: 7.22-7.78mmol/L, give 1 U regular insulin IV; 7.78-8.89 mmol/L, give 2 U regular insulin IV; 8.89 – 10mmol/L, give 3 U regular insulin IV; 10-11.11 mmol/L, give 5 U regular insulin IV; and >11.11mmol/L, notify physician.**
- 1 hour after Glucola load and insulin (if required) check PGL.
- If PGL is < 8 mmol/L **proceed with FDG injection.**
- If PGL is > 8 mmol/L **give 1U – 2U of regular insulin.**
- If PGL is 8.8 – 10 mmol/L **give 3U of regular insulin.**
- If PGL is 10 – 11.1 mmol/L **give 5U of regular insulin.**
- If PGL > 11 mmol/L **give up to 10U of regular insulin. Notify MD for insulin orders.**
- If PGL slightly > 8 mmol/L **have patient walk (if able) to help reduce blood glucose levels.**
- Injection of FDG 1 hour post glucose load (can be given at the same time as supplemental insulin, if required). (**ASNC – optimal BG should be between 5.55 – 7.77mmol/L to inject FDG**).
- PGL (re-check after 30 minutes if insulin was given).

- FDG imaging 45-60 minutes post FDG injection (refer to FDG imaging protocol).
- Patients receive nourishment after the procedure due to their fasting state. Normal blood sugar is 3.5 – 5.8 mmol/L. If the patient's blood sugar is lower than 3.5 mmol/L or patient exhibits symptoms of hypoglycemia, a drink of glucola may be required to raise the PGL to within the acceptable range.
- Assess post blood pressure, heart rate and final PGL. Refer to potassium protocol if supplemental insulin given.
- Diabetic patients may require closer monitoring of blood glucose levels and higher doses of insulin or additional doses of insulin if PGL does not stabilize/decrease. The glucose-insulin clamp protocol is an alternative method to be used for diabetic patients (preferred). **UOHI only uses the glucose-insulin clamp protocol for patients with known diabetes mellitus.**



PROTOCOL FOR BLOOD GLUCOSE MANAGEMENT IN DIABETIC PATIENTS UNDERGOING MYOCARDIAL TISSUE VIABILITY STUDIES WITH FDG PET

1) Glucose Insulin Clamp Protocol:

- Patients with known diabetes Mellitus.
- Hold diuretics (easier for patient to tolerate time in scanner).
- Patients must fast 6 – 12 hours (**ASNC- 6-12hours**). If fasting overnight, hold oral diabetic medications/insulin.
- Schedule diabetic patients in the morning (preferred). If diabetic patient is scheduled for afternoon, patient may have light breakfast and medications as required.

2) Patient Preparation:

- Two saline locks are required. One for insulin/glucose infusion and the other to check Plasma Glucose Level (PGL), this should be distal to the infusion lock or in the opposite arm. Finger pricks are an alternative to using the saline lock for checking PGL's if unable to access second I.V. site.
- Check Plasma Glucose Level (PGL) on glucometer (when drawing blood from IV use 1 cc TB syringe and discard 0.3 cc blood before checking the PGL. Remember to flush lock afterwards). Baseline potassium, glucose, creatinine blood tube drawn.
- If PGL is > 10 mmol/L, notify MD and obtain orders for insulin bolus prior to starting infusion. (i.e. MD may order: if PGL is 10 – 15 mmol/L **5U regular insulin**, if PGL is > 15 mmol/L **10U regular insulin**)
- Calculate amount of insulin to be used for clamp.
Insulin dose: pt's weight (kg) x 0.25 = # of IU of

regular insulin to be added to NaCl 50 cc bag. **UOHI – we double the dose of insulin to be added to 100 cc volume bag.**

- Resting perfusion scan must be performed prior to FDG imaging if scan is on the same day as FDG. If scan is performed on separate day, it must be within 2 weeks of FDG scan (if patient stable, unstable patients resting scan must be on same day as FDG imaging).

3) **Insulin Infusion:**

- Run IV insulin infusion as per Glucose Insulin Clamp Data sheet.
- 48 cc/hour x 4 minutes.
- 24 cc/hour x 3 minutes.
- 12 cc/hour for remainder of infusion.
- **Check PGL every 5 minutes.** If patient exhibits symptoms of hypoglycemia, check PGL sooner.
- Best images are obtained when PGL is approximately 5 mmol/L. **NOTE:** PGL is patient specific, therefore adjust as tolerated. Goal is to see a decrease in PGL.
- If after initial load patient PGL not dropping, patient may need additional regular insulin bolus (2U at a time).

4) **Glucose Infusion:**

- An exogenous 20% glucose infusion is started (if required) at a rate of 1 – 5 cc/hour and adjusted until a steady state is achieved. The glucose infusion is adjusted according to the PGL over the preceding 5 minutes. Glucose infusion is usually started after insulin infusion. Glucose infusion start time varies depending on the patients PGL. For example, in a case where the patients fasting blood sugar is low (i.e. took insulin, but

did not eat) then the glucose infusion will be started prior to the insulin infusion.

- FDG injection (PGL is stable and beginning to decrease). FDG imaging see FDG imaging protocol.
- Turn off insulin approximately 30 minutes post FDG injection. Do not turn off the glucose infusion (if running). Continue to check PGL for another 20 – 30 minutes depending on PGL and turn off the glucose infusion when the PGL has returned to baseline.
- Patients receive nourishment after the procedure due to their fasting state. Normal blood sugar is 3.5 – 5.8 mmol/L. If the patient's blood sugar is lower than 3.5 mmol/L or he/she exhibits symptoms of hypoglycemia, a drink of glucola may be required to raise the PGL to within the acceptable range.
- Assess post blood pressure, heart rate and final PGL.
- Slow K+: document if given or not required. See potassium protocol.

PROTOCOL FOR BLOOD GLUCOSE MANAGEMENT IN PATIENTS UNDERGOING MYOCARDIAL TISSUE VIABILITY STUDIES WITH FDG PET

1) Potassium Protocol:

- All diabetic and non-diabetic patients booked for a FDG viability scan will have potassium (K⁺), glucose and creatinine levels drawn on the day of the study.

2) Procedure:

- If K⁺ level is > 4.0 mmol/L **No supplement is required.**
- If K⁺ level is 3.5 – 3.9 mmol/L **Give Slow K (3 tablets) at the end of the scan.**
- If K⁺ level is < 3.5 mmol/L **Give Slow K (3 tablets) ASAP and draw a stat K⁺ level at the end of the scan. Follow up with a K⁺ level the next morning.**
- If K⁺ level is < 3.0 mmol/L OR an abnormal creatinine level **Individual patient orders are received from the physician.**