# Cardiac Sarcoidosis Imaging: PET*

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## RATIONALE

Sarcoidosis is a systemic disease of unknown etiology that most frequently affects the lungs but infrequently manifests in the heart (10%–30%). The disease is characterized by nonnecrotizing granulomatous inflammation with accompanying fibrosis (infiltration of granulomas and heart scarring).

Cardiac sarcoidosis is difficult to diagnose due to nonspecific clinical presentation such as conduction abnormalities, tachy- and bradyarrhythmia, and heart failure. Glucose metabolism is increased in inflammatory cells and can be detected using $^{18}$F-FDG ($^{18}$F-FDG). Cardiac sarcoidosis is diagnosed using a combined $^{18}$F-FDG PET and resting myocardial perfusion protocol to detect inflammation and fibrogranulomatous replacement of the myocardium.

## CLINICAL INDICATIONS

- Suspected clinical diagnosis in cases of equivocal findings in prior investigations.
- Assessment of disease extent.
- Assessment of pulmonary disease activity.
- Assessment of cardiac sarcoidosis in the following scenarios:
  - Biopsy-proven extracardiac sarcoidosis with abnormal screening for cardiac involvement.
  - Unexplained new conduction abnormality in patients below the age of 60.
  - Assessment of response to therapy in cardiac sarcoidosis.

## CONTRAINDICATIONS

- Pregnant/breastfeeding: Pregnancy must be excluded according to local institutional policy. If the patient is breastfeeding, appropriate radiation safety instructions should be provided.
- Recent nuclear medicine study (radiopharmaceutical dependent).

## PATIENT PREPARATION/EDUCATION

- The patient should eat at least 2 high-fat, low-carbohydrate meals the day before the test and fast for at least 4 to 12 h. Water is permitted. Note: Complying with a high-fat, very low carb diet for 24 h can suppress myocardial glucose utilization in up to 80% of patients, and extending the diet to 72 h can yield a 95% suppression rate.
- Patients who cannot follow the dietary recommendations should fast for more than 18 h before the test.
- Patients with type 1 diabetes should continue basal insulin and avoid or minimize rapid-acting insulin if it is safe to do so.
- Patients with type 2 diabetes should not take oral agents or noninsulin injections while fasting or on the morning of the test.
- The patient's blood glucose level should be measured before $^{18}$F-FDG administration.
- A focused history containing the following elements should be obtained. These include indication for the examination; a history of extracardiac sarcoidosis; electrocardiogram findings, especially atrioventricular block, ventricular tachycardia, bundle branch blocks, etc.; medications; symptoms; previous cardiac history, including myocardial infarction; and results of prior diagnostic or therapeutic procedures, including echocardiogram, cardiac MRI, cardiac catheterization, and myocardial perfusion imaging.

## PROTOCOL/ACQUISITION INSTRUCTIONS

- Radiopharmaceutical and pharmaceutical identity, dose, and route of administration are provided in Tables 1 and 2, respectively.

**TABLE 1**
Radiopharmaceutical Identity, Dose, and Route of Administration

| Identity | Dose | Route of administration |
|---|---|---|
| $^{18}$F-FDG | 370 MBq (10 mCi)<br>Range: 185–555 MBq (5–15 mCi) | Intravenous |

*Adapted from Farrell MB, Thomas KS, Mantel ES, Settle J. *Quick-Reference Protocol Manual for Nuclear Medicine Technologists.* 2nd ed. Society of Nuclear Medicine and Molecular Imaging–Technologist Section; 2024:24–27.


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**TABLE 2**
Pharmaceutical Identity, Dose, and Route of Administration

| Identity | Dose | Route of administration |
|---|---|---|
| Unfractionated heparin | 10 IU/kg 30 min prior + 5 IU/kg<br>15 min prior or 50 IU/kg<br>15 min before radiotracer administration | Intravenous |

- Acquisition parameters for PET and PET/CT are provided in Table 3.
- Acquisition instructions:
  - Before the $^{18}$F-FDG scan, the patient must have a PET myocardial perfusion study at rest with either $^{82}$Rb or $^{13}$N-ammonia (see PET Myocardial Perfusion Protocols in this section). If PET perfusion is unavailable, SPECT imaging with $^{99m}$Tc-sestamibi or $^{99m}$Tc-tetrofosmin, preferably with attenuation correction, is acceptable. The rest myocardial perfusion study can be performed on the same or different days. Note: If an $^{18}$F-flurpiridaz rest study is acquired prior to the $^{18}$F-FDG scan, increased time between $^{18}$F-flurpiridaz and $^{18}$F-FDG is required.
  - Inject the heparin per department protocol. Note: The impact of unfractionated heparin (UFH) may be lower than initially understood. Consequently, the use of UFH continues to present ambiguous value and is a topic of debate.
  - Inject the $^{18}$F-FDG.
  - Wait 60 to 90 min after injection to begin imaging.
  - Place the patient supine, arms above the head and out of the camera's field of view.
  - Obtain a dedicated cardiac scan followed by a partial whole-body scan, including the lungs and mediastinum.

## IMAGE PROCESSING

- Process PET images per the manufacturer's recommendation, including preprocessing, attenuation correction, reconstruction method (e.g., iterative methods such as ordered-subset expectation maximization [OSEM] or filtered back projection), and filter selection (sufficient to achieve desired resolution/smoothing).
- Because many patients have cardiac devices, if PET/CT is performed, focal hot spots corresponding to device leads may be noted. Therefore, both attenuation-corrected and nonattenuation-corrected images should be reconstructed.
- The images should be reconstructed into standard cardiac short axis, vertical long axis, and horizontal long axis views.
- Align the perfusion and $^{18}$F-FDG slices to match the same sections of the myocardium.
- The rest myocardial perfusion and $^{18}$F-FDG images should be displayed with image intensity normalized to the maximum counts per pixel. Note: Normalization of

**TABLE 3**
Acquisition Parameters: PET or PET/CT

| Parameter | Specification | Standard/preferred/optional |
|---|---|---|
| Camera type | PET/CT | Preferred |
| | PET | Standard |
| Energy peak | 511 keV | Standard |
| Injection-to-imaging time | 60–90 min | Standard |
| Attenuation correction | PET/CT: CT acquisition | Standard |
| | PET: cesium or germanium sources | Standard |
| Patient position | Supine | Standard |
| Arm position | Arms overhead | Standard |
| Acquisition mode | 2- or 3-dimensional | Standard |
| Number of bed positions | Varies | Standard |
| Time/bed position | Partial whole-body scan: | Standard |
| | 2-dimensional: 4 min | |
| | 3-dimensional: 3 min | |
| | Dedicated cardiac scan: | |
| | 2-dimensional: 20–30 min | |
| | 3-dimensional: 10 min | |
| View | Chest, including the lungs and mediastinum | Standard |
| CT acquisition | Per the manufacturer's recommendations for attenuation correction or diagnostic imaging | Optional |

the $^{18}$F-FDG slices may be challenging due to the nature of hot spot imaging, as normalization can accentuate areas of mild $^{18}$F-FDG uptake. A normal cardiac sarcoidosis PET scan will demonstrate complete myocardial $^{18}$F-FDG suppression and normal resting myocardial perfusion.

- Display the images and other quantification data/images, such as polar plots.

## ADJUNCT IMAGING/INTERVENTIONS

- Myocyte glucose uptake can be suppressed by administering unfractionated heparin (10 IU/kg) intravenously 30 min before tracer administration plus 5 IU/kg 15 min before tracer administration or 50 IU/kg 15 min before tracer administration.
- The patient should have no contraindications to the administration of intravenous heparin, such as bleeding tendencies, allergy, or history of heparin-induced thrombocytopenia with thrombosis.
- Limited whole-body PET study should be considered if there is a clinical suspicion of extracardiac sarcoidosis.

## DISCLOSURE

No potential conflict of interest relevant to this article was reported.

## REFERENCES


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