Myocardial SPECT checklist

Acquisition	Checklist	See page
• Choice of nuclide	A Tl or Tc agent is used for myocardial perfusion imaging, a Tc-99m agent is advantageous for gated SPECT, BMIPP is used for fatty acid metabolism assessment, and MIBG for sympathetic nervous function detection. When an I-123 agent is used, the collimator must also be chosen with care.	2
• Dose	At least 111 MBq is recommended for Tl, while for Tc agents 592–740 MBq is recommended for the study at rest, with this dose increased by at least 2.5 times for the second study if performed during the same day according to stress-rest or rest-stress protocols, with an upper limit of a total of 1110 MBq. For BMIPP and MIBG, 111 MBq is recommended, and all these doses must be adjusted appropriately for children.	2
• Time between administration and start of acquisition	Tl at rest : 20 min after administration. Tl stress redistribution : 5–10 min and 3–4 h after administration. Tc agents : Generally 30–60 min after administration (however, the accumulation of Tc agent in the hepatobiliary system varies during exercise stress, pharmacological stress, and at rest, and individual variation also occurs, meaning that it should be taken into account before the start of acquisition). BMIPP : 15–20 min after administration and in some cases 3–4 h after administration. MIBG : 15–20 min and 3–4 h after administration.	2
• Stress method (exercise/ pharmacological)	Pharmacological stress is effective if sufficient exercise stress is difficult. Comply with the timings of drug and RI administration.	2
• Pretreatment	If Tl is used, patients must fast from 4 h before the test until the scan is complete. If a Tc agent is used, some institutions do not ask patients to fast, and others ask them to fast before administration but permit food consumption afterwards. Fasting is required for BMIPP, and for MIBG attention must be paid to the use of other drugs.	2
• Patient body type/sex	The degree of scatter and attenuation varies depending on patient body type and sex (the pectoral muscles in males, breasts in females, etc.)	
• Energy window	Tl : Generally 71 KeV ± 10%–15%, sometimes with an additional 167 KeV ± 10%. Tc : Generally 140 KeV ± 10%. I : Generally 159 KeV ± 10%.	2
• Number of detectors	Multidetector devices are most suitable, and single-detector devices are limited to an acquisition range of 180°.	1
• Positioning of detectors	Triple-detector devices have the detectors arranged in a triangle, while with dual-detector devices it is possible to choose between opposing positions, a 90° L-shape, or a 76° acute angle.	1
• Acquisition range (180°/360°/207°)	360° acquisition is stable, with little distortion of the inferior and posterior walls, and little change in count from the apex to the base of the heart. 180° acquisition provides particularly high contrast and good resolution of the anterior wall.	1
• Collimator	In general, LEHR and LEGP collimators can be used with both Tc and TI, but in particular, when Tl is used with a short acquisition time or gated acquisition, an LEGP collimator may be used if the count is insufficient. I agents have a 529 keV peak in addition to the main peak at 159 keV, and the effect of down scatter must therefore also be taken into account. Collimators are chosen with reference to their 5% penetration energy and taking the balance between sensitivity and resolution into account.	1
• Pixel size (matrix size and magnification)	Pixel size = standard visual field/matrix/acquisition magnification. From sampling theorem, a pixel size of 5–7 mm and sample angle of 5–6° are appropriate.	2
• Number of sampling directions	In general, sampling is carried out from 72 directions with a sample angle of 5° and from 60 directions with a sample angle of 6°.	2
• Acquisition time	Generally, the acquisition time for a single direction is set within the range 20–40 s, but this is dependent on the dose and body type. The effect of a decline in count due to washout must be taken into account for Tl late images. Limitations imposed by throughput affect the total acquisition time, as do the number and positioning of detectors and the acquisition range. The longest time for which patients can endure keeping their arms raised and remain motionless is around 20 min.	2
• Acquisition mode	Continuous rotation acquisition has a number of merits, including a shorter total acquisition time and fewer artifacts, caused by factors such as body movements. Only step acquisition can be used for gated SPECT.	2
• Diameter of rotation	For patients with a standard body type, the diameter of rotation is 200–250 mm, close to the body.	3
• Circular trajectory/ close-proximity trajectory	A close-proximity trajectory increases the contrast but may also cause artifacts, and an extremely elliptical trajectory should therefore be avoided. When using 180° reconstruction, an extremely close-proximity trajectory may result in so-called eleven-o'clock false defects.	
• Number of R-R divisions	For Tl , in principle 8 divisions are used. With Tc agents, some institutions believe it is possible to use up to 16 divisions.	2

• Tolerance	A few dozen heartbeats must be monitored prior to gated SPECT acquisition, and the window set so that the base of the histogram is not lost.	
• Acquisition count standards	A region of interest (ROI) is set in the myocardial region of the LAO45° of the projection data, and the myocardial projection count is measured. The acquisition time should ideally be set to obtain over 100 counts per pixel in the myocardium.	3

Reconstruction	Checklist	See page
• Body movement correction	SPECT scan is susceptible to upward creep and body movements. If body movements occur, SPECT images are often shown up as defective. Try using correction software if this is available. Correction cannot be performed, however, if the patient has turned over, or has given a large cough or taken a deep breath during acquisition from one direction. At best, correction can only be performed for the X and Y axes for each direction of projection.	5
• Scatter correction	The TEW method is often used, but although it is capable of improving the contrast between the cardiac cavity and the myocardium, the values for the inferior wall are lowered as a result of correction. The count may decrease by 30%–40%. Scatter correction is rarely used alone for the myocardium.	4
• Preprocessing filters	The higher the cutoff frequency of a Butterworth filter, the better is the resolution but the greater the amount of noise, and the lower the cutoff frequency, the lower is the resolution and the smoother the image obtained. The visual inspection of clinical data is important.	4
• FBP/OSEM (Iterations, subsets)	OSEM can also be employed to reduce streak artifacts caused by the high uptake of Tc agents outside the myocardium. X-ray CT attenuation correction may also be performed by using OSEM. As a guideline, each subset should include data for 10 projections, with 5 iterations. For example, 6 subsets and 5 iterations are used for 60 projections. A low number of data updates (subsets × iterations) may result in incomplete convergence in the defect area.	4
• Attenuation correction	Attenuation correction methods (such as Chang's method) that assume homogeneous absorbers cannot provide accurate correction because the chest is composed of heterogeneous absorbers such as the lungs, spine, heart, and mammary glands. OSEM can be incorporated into the processing if X-ray CT can be used to create an attenuation map, but simultaneous scatter correction is essential.	4
• Image reformatting	Select a central slice of the myocardium, and join the centers of the anterior and posterior walls, passing through the apex and the centers of the lateral wall and septum.	

Display	Checklist	See page
• Count normalization	Check that the maximum count in the myocardium is shown as 100%. If any extramyocardial hotspots are present, carry out count truncation. If this is not feasible, decrease the upper level so that the maximum count in the myocardium become to the highest color.	7
• Cut level	Generally, the upper level is set at 100%–110% and the lower level at 10%–20%. If scattering correction has been carried out, however, the lower level is set at 0%. Take care to ensure that the maximum counts in the myocardium are consistent.	6
• Gradient	A exponential or quadric function is recommended for black-and-white images, and a linear gradient for colored images. This enables the accurate assessment of ischemia and viability, and assessment of the right ventricle and background, which also provide important data on cardiac function.	6
• Black and white images	Display as positive images. A exponential or quadric function is recommended. An excessive lower cut should be avoided.	6
• Color images	Be aware that the choice of color coding may have a major effect on evaluation. Avoid an excessive lower cut when using a linear gradient. Coding with the maximum myocardial count displayed in white or pink is appropriate for diagnostic purposes.	6
• Display slice thickness	In image display, the vertical long axis runs from the septum to the side of the lateral wall, the short axis from the base of the heart to the apex, and the horizontal long axis from the inferior wall to the anterior wall, with slice thickness of 5–7 mm, displayed in a total of 9–16 divisions.	7
• Layout	Arrange the same slices for every axis to compare stress images to rest images. Use techniques such as arranging images on two levels to make them easier to view.	7