Myocardial Perfusion Scintigraphy – Reporting Document

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Chapter 1: Introduction

Myocardial perfusion scintigraphy (MPS) is widely used in the assessment of patients with coronary artery disease (CAD). It is based on the principle that radiotracer uptake is dependent on both adequate delivery of the tracer through coronary blood flow, as well as adequate tracer retention by viable myocardium.

For detection of coronary artery disease on MPS, some form of stress that will increase coronary flow is necessary since coronary flow may be normal at rest until critical artery narrowing (approximately 90% stenosis) is reached.

Exercise causes coronary dilatation to meet increased oxygen demand. Stenosed arteries are referred to as fully recruited, meaning they are unable to dilate more to accommodate higher blood flows. Vasodilators (adenosine, dipyridamole, and regadenoson) are used to dilate normal arteries without increasing myocardial work load, but diseased arteries are unable to dilate further. The inotropic agent dobutamine acts similarly to exercise.

The increased flow in normal arteries after exercise or pharmacological stress results in increased radiotracer delivery to normal areas, and a relative decrease in the areas supplied by stenosed arteries. Conventional MPS, therefore, usually only shows relative, not absolute, coronary flow and this principle might run counter to what is written in the report.

While a defect is described as reduced perfusion in the scan, in fact there may be an actual slight increase in perfusion, but not as much as in the normal areas with 2 to 3 times increase in flow from baseline. Also, there is the so called “balanced ischemia” where there is generalized decrease in perfusion, but the images may look normal because relative decrease in uptake is uniform. Likewise,

dilated hearts may have uniform tracer distribution but is not normal.

Chapter 2: Indications

The indication for the study, with either exercise or pharmacological stress, should ideally be appropriate, in keeping with current guidelines. It is anticipated that each centre has a > 80-90 % "appropriate indication rate." If not, this will need discussion within each group and with referring physicians. Appropriate studies are more likely to be positive, lead to more revascularization, and result in correct utilization and minimization of ionizing radiation and cost.

Reporting physicians should be familiar with the following document that lists clinical indications in symptomatic and asymptomatic patients, and compares the appropriateness of each condition with other modalities.

To summarize, indications can be broadly classified into diagnostic or prognostic, depending on whether coronary disease within the patient is known to be present.

Indications include:

2.1 Diagnostic

1. Equivocal or non-diagnostic stress testing, including stress echocardiography.
2. Marked ECG changes at baseline e.g. LBBB (and others).
3. Intermediate to high probability pre-test probability patients, where quantitation of the amount of ischemia will guide management.
4. Patient unable to exercise, requiring a pharmacological stressor (The ECG alone with pharmacological testing has an approximately 20 % sensitivity and hence some form of imaging is needed).
5. Prior to high risk non-cardiac surgery in intermediate risk patients

2.2 Prognostic

1. Identifying functional significance of a coronary lesion (e.g., post angiography or a 50-70 % lesion on CTCA).
2. Assessing for ischemia post MI, in patients who, for whatever reason, did not have coronary angiography.

3. Assessing for recurrent pain/symptoms post revascularization.
4. Myocardial viability

This list is not exhaustive, and each patient must be assessed on his/her merits.

The clinical indication written in the report should be concise and preferably 2 lines or less. It should include the "question being asked", which will ultimately be answered in the conclusion, and any important correlative results (e.g. 50 % LAD lesion on angiography or equivocal stress echo). The recorded information should be sensitive to the referring clinician's request and should not be hostile or inflammatory. A clinical indication from the above lists may be recorded as required.

Chapter 3: Radiopharmaceuticals

Thallium-201 chloride was the first commonly used radiotracer and is still in use today. It has good myocardial extraction fraction. After initial distribution into the myocardial segments, Tl-201 washes out of the myocardium and redistributes into areas with less uptake. This allows a single injection to be administered during peak hemodynamic response to exercise or vasodilators, and the properties of washout and redistribution allows imaging at rest after a few hours. Because of its ability to redistribute, Tl-201 is the preferred agent for myocardial viability assessment. Tl-201 has a low gamma energy peak, and its long half-life results in high radiation dose to the patient.

Technetium-99m-labeled sestamibi and tetrofosmin have several advantages and are preferred for routine ischemia detection. Tc-99m has superior physical characteristics such as optimal gamma ray energy, and the 6-hour half-life delivers less radiation to the patient, compared to Tl-201. Sestamibi and tetrofosmin exhibit insignificant washout and redistribution, and thus require two separate injections. This provides some flexibility in that the stress or the rest may be done first within the day, or may be done on separate days. Imaging may be performed up to a few hours after injection, unlike Tl-201, which requires imaging within 30 minutes due to the tracer washout. This may be important if the patient is unstable, particularly after undergoing stress.

Tc-99m agents, however, suffer from some disadvantages such as lower extraction fraction than Tl-201, and the high extra-cardiac tracer activity usually inferior to the heart that interferes with defect assessment or produces relative reduction in counts in the myocardium.

Chapter 4: Imaging Protocols

Stress protocols may either be by exercise (treadmill or cycle ergometer), or pharmacological means. Exercise is the preferred form of stress because of the additional prognostic information obtained from exercise capacity. Pharmacological stress is used if the patient is unable to exercise adequately, and may utilize vasodilators (adenosine, dipyridamole, regadenoson) or inotropics (dobutamine). Vasodilators are contraindicated in patients with severe or active bronchospastic disease, and dobutamine is the preferred agent in these cases. In LBBB, vasodilators are the preferred method of stress, as higher heart rates will increase the possibility of a false positive septal reversible defect.

The imaging protocols depend on which radiopharmaceutical is used:

4.1 Tl-201 thallous chloride protocols:

1. Stress-rest-delayed redistribution for diagnosis of CAD. A reinjection dose of thallium-201 of 50 % of the stress dose is frequently required approximately 1 hour before rest imaging, if the stress image was abnormal.
2. Rest-redistribution (and possibly delayed redistribution at 24 hours) for myocardial viability assessment not requiring ischemia evaluation.

4.2 Tc-99m sestamibi or tetrofosmin protocols:

1. Rest-then-stress (one-day protocol).
2. Stress-then-rest (one- or two-day protocol, where the rest imaging is optional if the stress images are normal).

Tc-99m agents may be used for myocardial viability assessment by giving a prior dose of nitrates (sublingual, topical, or oral [oral nitrates might take a bit of time before taking effect]) just before the rest injection.

CT attenuation correction can be added to help exclude artefact and evaluate for coronary artery calcium.

As previously stated, the clinical indications and patient's condition

directly impacts which imaging protocol will be used, as well as the wordings used in the MPS report. Thus, there should be concordance among the indication, condition, protocol and the scan report.

A detailed discussion of the protocols is beyond the scope of this document. The readers are advised to consult the references listed at the end.

Chapter 5: Reporting Essentials

As in any scan report, there should be a short description of the patient's clinical impression, the indication for the scan, scan protocol, scan findings and interpretation, comparison with prior studies, and recommendations if any.

Enough clinical information should be included in the report that may have a bearing on the findings (e.g. beta-blocker medication resulting in attenuated heart rate and blood pressure response to exercise, or antianginal medication that may lead to a false negative scan, or active bronchospastic disease that led to the decision to use dobutamine stress). The ECG and hemodynamic response to stress must be described in the scan report. Technical information that affect the images, for example if CT attenuation correction was used, should be mentioned.

A detailed description of the defects constitutes the main portion of the report. The use of the 17-segment model (Figure 1) is currently recommended, not only for nuclear cardiology but also for other imaging modalities like echocardiography, cardiac CT and cardiac MRI. The 17 segments are distributed into the main coronary artery territories, with the understanding that substantial variability in coronary artery anatomy exists.

Severity of perfusion defect is described as normal, mild, moderate, severe, or absent (background activity only). The labelling abnormalities must consider normal variants and common artefacts. For instance, a prominent apical slit, or decreased labelling in the anterior wall in women and in the inferior wall in men due to attenuation, are considered normal and not counted as defects. Defects seen at stress that improve completely at rest, are considered as stress-induced ischemia. Severe defects that persist at rest indicate myocardial infarct or fibrosis. Mild or moderate defects represent partial thickness scar with viable myocardium.

A semi-quantitative scoring system is widely used where defect severity is numbered 0 (normal), 1 (mild defect), 2

(moderate defect), 3 (severe defect), or 4 (absent activity), again considering normal variants and common artefacts. Summed scores are useful and have been shown to have prognostic value. Adding the individual scores in all 17 segments in the stress images gives the Summed Stress Score (SSS), a measure of defect severity and extent. Summing the scores in the rest images gives the Summed Rest Score (SRS), which can be a measure of non-viable myocardium (and conversely, viable myocardium). Subtracting the SRS from the SSS provides the Summed Difference Score (SDS), which is a measure of stress-inducible ischemia. The SSS, SRS, and SDS are unitless parameters, and non-intuitive unless one is familiar with the 17-segment model. Some, therefore, prefer to normalize these scores by dividing them by 68, which is the maximum possible score. The corresponding normalized scores are called SS%, SR% and SD%, respectively. These are presented as percentages and thus are more intuitive. For instance, an SS% of 25% is more meaningful than an SSS of 17, although they describe the same labelling defects. Figures 2, 3, 4 and 5 are examples of defects with their corresponding scores and perfusion interpretation. An SSS of less than 4 is generally normal.

Gated SPECT is the standard of care, and both qualitative and quantitative data should be reported. Wall motion abnormalities should be described as hypokinesia (decreased wall motion), akinesia (insignificant wall motion over and above the tethering effect of motion in adjacent segments), and dyskinesia (paradoxical motion commonly seen in large infarcts where the fibrotic segments move outward during systole, and vice versa, because of the lack of contracting viable myocardium). Left ventricular volumes at end systole and end diastole, as well as ejection fractions should be reported. LV ejection fraction is normally >50% (>45% is acceptable in males).

The decision to include quantitation in reports does vary between institutions. While nearly everyone would agree that LVEF should be reported, the decision to include quantification of the perfusion defect and LV volumes does vary according to institutional preference, including the needs of the referrer. Despite this, the data should be reviewed by the reporting doctor, even if not recorded in the final report.

High risk MPS findings include a large area of reversible ischemia, high lung thallium uptake, transient ischemic dilatation, and right ventricular hypertrophy. These must be included in

the report if present. Incidental findings should also be incorporated in the report, specially such as possible masses seen on both SPECT and CT. Similarly coronary calcium should be commented upon, particularly in diagnostic cases with no known prior CAD.

Finally, the interpretation or impression section should clearly convey the message of the scan findings, and should state whether the scan is normal, abnormal or equivocal. It must answer the clinical question being asked, e.g. myocardial ischemia, functional significance of coronary stenosis, risk stratification, prognostication, or myocardial viability. A recommendation may be added if appropriate.

EANM and EACVI position paper on nuclear cardiology report writing recommends the following: avoid the use of technical terms as the clinician is probably unfamiliar with these; avoid the use of abbreviations and technical information not important to referring physician; qualitative descriptions (e.g. small, large, moderate, severe) should be quantitative if possible; minimize protective/hedging expressions (e.g. likely, cannot be excluded).

Urgent or unexpected results should be communicated to referrers ASAP by telephone.

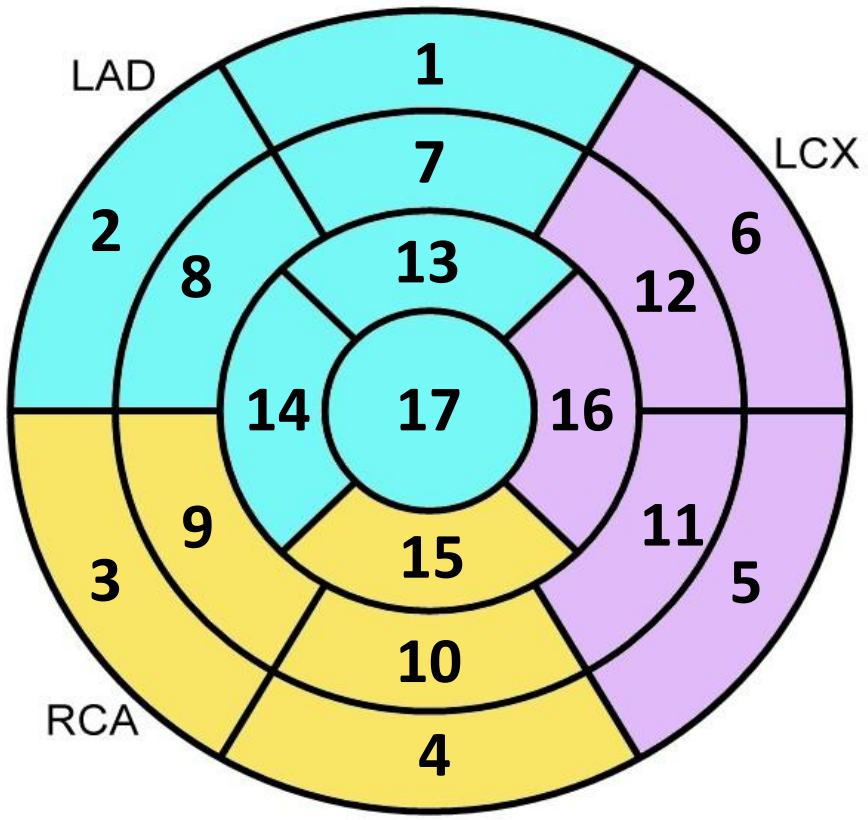
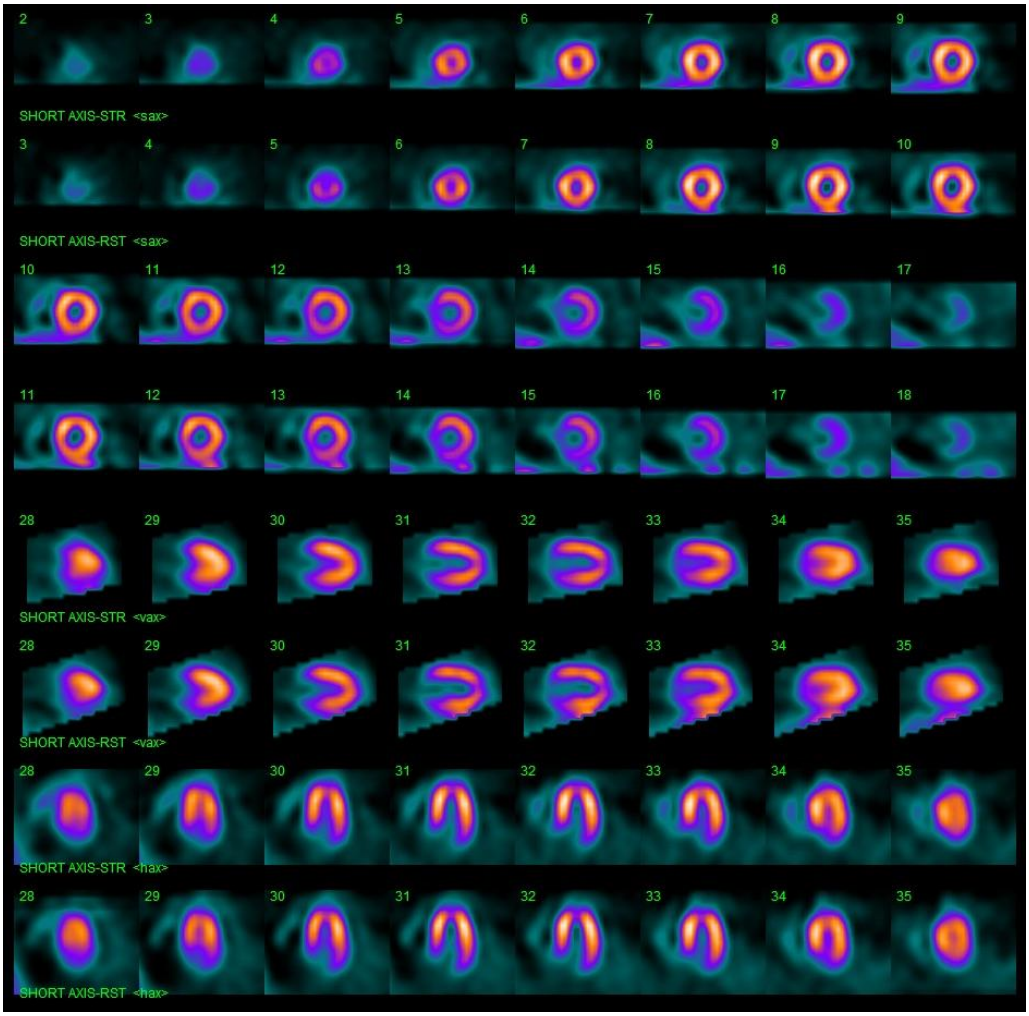


Figure 1: 17 segment model used for reporting myocardial perfusion scintigraphy

1 – Basal anterior
2 – Basal anteroseptal
3 – Basal inferoseptal
4 – Basal inferior
5 – Basal inferolateral
6 – Basal anterolateral
7 – Mid anterior
8 – Mid anteroseptal
9 – Mid inferoseptal
10 – Mid inferior
11 – Mid inferolateral
12 – Mid anterolateral
13 – Apical anterior
14 – Apical septal
15 – Apical inferior
16 – Apical lateral
17 – Apex

5.1 Example 1: Normal Stress – Rest MPS



Scintigraphy Finding:

Stress images:

There was normal tracer distribution in the myocardial segments.

The left ventricle was not enlarged.

Rest images:

The myocardium showed normal tracer uptake.

No focal defect seen.

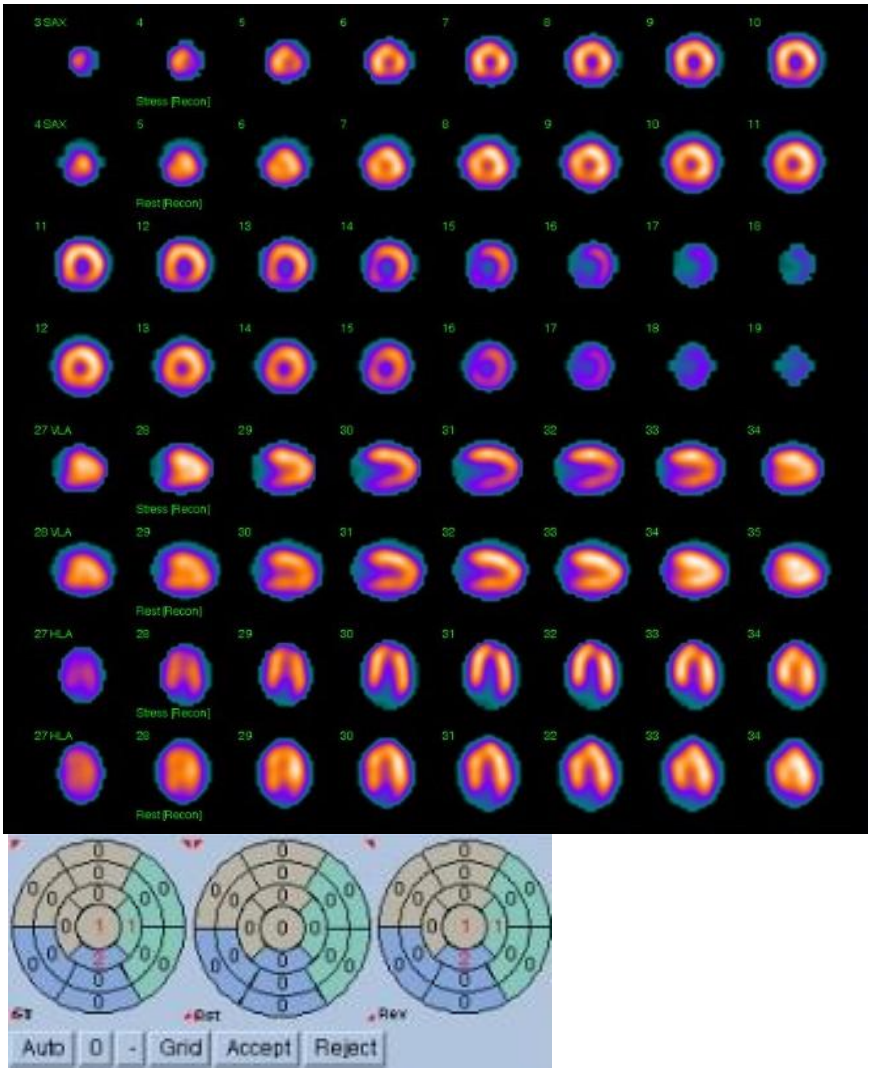
SSS = 0. SS% = 0.

Interpretation:

Normal dipyridamole stress myocardial perfusion scintigraphy.

No evident stress-induced myocardial perfusion abnormality.

5.2 Example 2: Mild Stress Defect – Normal Rest



Scintigraphy Finding:

Stress images:

There was mild reduction in tracer uptake in the basal to apical inferior segments, and the apex.

The left ventricle was not enlarged.

Rest images:

The myocardial segments exhibited normal tracer uptake.

The defects seen at stress resolved completely.

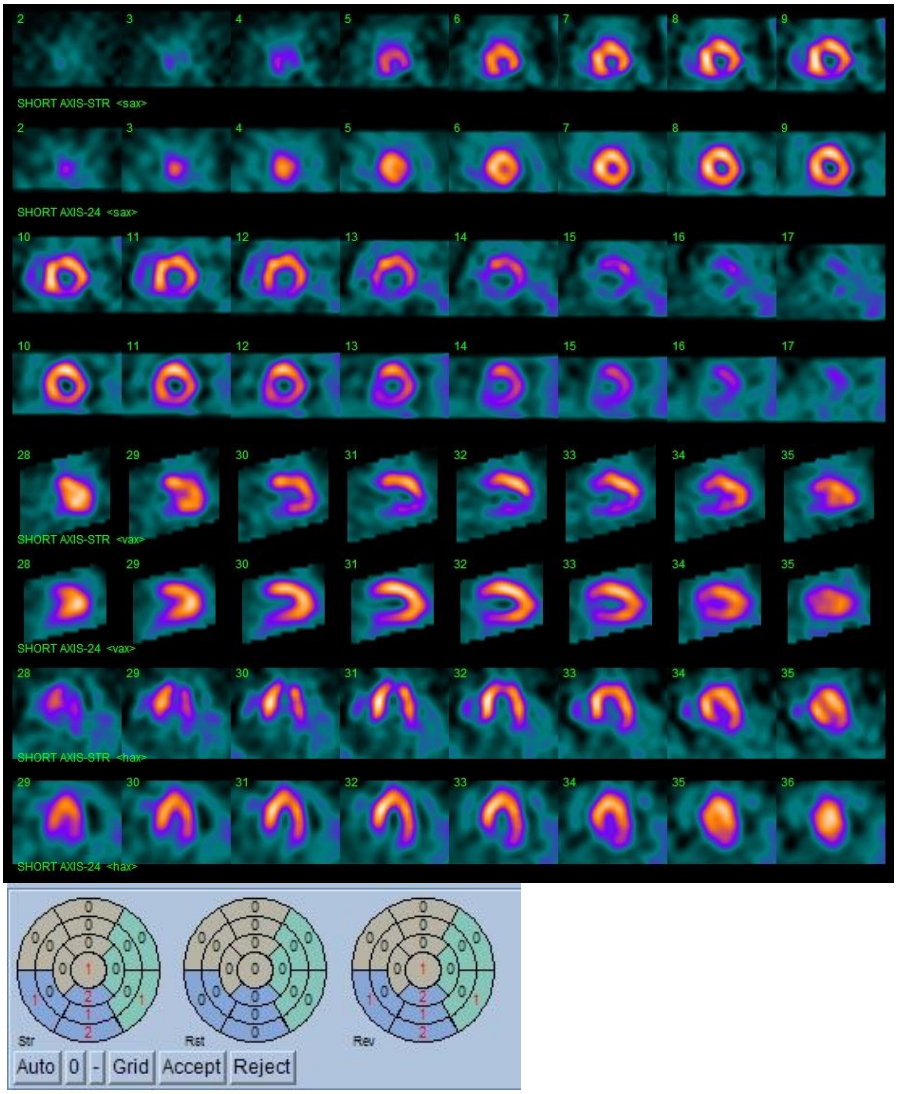
Interpretation:

Abnormal treadmill exercise myocardial perfusion scintigraphy.

Mild stress-induced ischemia in the basal to apical inferior segments, and the apex.

SSS = 4	SRS = 0	SDS = 4
SS% = 5.9%	SR% = 0%	SD% = 5.9%

5.3 Example 3: Moderate Stress Defect – Normal Rest



Scintigraphy Finding:

Stress images:

There were moderate defects in the basal to apical inferior segments, and the apex.

The left ventricle was not enlarged.

Rest images:

The myocardium showed normal tracer uptake.

The defects seen at stress completely resolved.

Interpretation:

Abnormal stress myocardial perfusion scintigraphy.

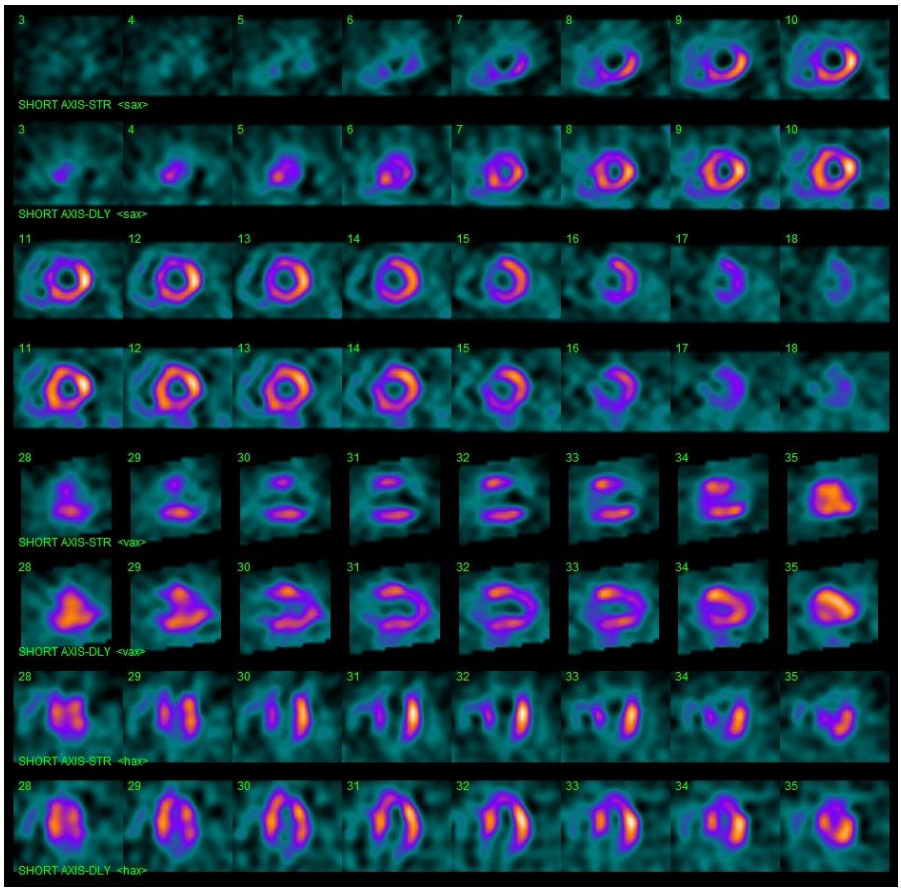
Moderate stress-induced ischemia involving the inferior wall and the apex (4 of 17 segments, 24% LV extent).

SSS = 8 SRS = 0 SDS = 8

SS% = 11.7% SR% = 0% SD% = 11.7%

(Teaching points: The stress defects may look severe, but adjustment must be made for attenuation artefact in the inferior segments. The rest images still showed mild to moderate tracer reduction in the basal and mid inferior segments, especially relative to the anterior segments, but these are considered attenuation artefacts, and the images are described as normal. Note that the quantitation software (QPS) actually considered the stress defects as mild to moderate only, and the rest images as normal.)

5.4 Example 4: Severe Stress Defect



Scintigraphy Findings:

Stress images:

There was absent (background only) tracer uptake in the apical anterior and septal segments, and the apex. Severe defects seen in the basal to mid anterior and anteroseptal segments, the apical lateral and inferior segments.

The left ventricle was not enlarged.

Rest images:

The defects seen at stress showed almost complete reversal. Mild defects were persistent in the apical anterior and septal segments, and the apex.

Transient ischemic dilatation noted in the apical third of the LV.

SSS = 27 SRS = 3 SDS = 24

SS% = 40% SR% = 4% SD% = 35%

(Notes: SSS = score of 4 in apical anterior, apical septal, and apex = 12; score of 3 in basal anterior, basal anteroseptal, mid anterior, mid anteroseptal; and apical inferior segments = 15; total of 27)

Interpretation:

Abnormal dipyridamole stress myocardial perfusion scintigraphy.

Large area of inducible ischemia involving the anterior and anteroseptal segments, and the apex (7 of 17 segments, 41% LV extent).

All myocardial segments are viable.

Chapter 6: Pitfalls and Artefacts

The scan must be assessed for technical adequacy prior to being interpreted and reported. Artefacts are produced by a variety of reasons, and awareness of these can avoid incorrect scan interpretation.

Inadequate exercise, or intake of food and medications that interfere with vasodilator stress, can reduce the sensitivity of the scan by being false negative. Extravasation of the tracer will lead to inadequate counts, and poor image quality. If using technetium-based tracers, extravasation may result in shine-through of prior injected activity. Extravasation of thallium will interfere with washout and redistribution, aside from having inadequate image counts. Extravasation of thallium also runs the small risk of radiation necrosis and should be alluded in the report (and mentioned to the patient with the appropriate advice).

During the scan acquisition phase, artefacts can be caused by inadequate gamma camera quality control (e.g. uniformity and centre of rotation), blank frames during SPECT rotation, gating errors, and patient motion. Acquiring the image too early after exercise stress may lead to the phenomenon of "upward creep" of the heart, resulting in a motion artefact.

Incorrect processing of the images for review (e.g. choice of LV axis, normalization of image brightness and contrast, alignment of rest and stress images) may result in defects being reported. High extra-cardiac tracer activity, seen with the technetium-based agents or with vasodilator stress, may falsely reduce overall relative myocardial activity, or may produce a focal defect due to filtering during SPECT reconstruction.

Soft tissue attenuation artefacts (commonly decreased uptake in the inferior wall in males and in the anterior wall in females), are seen in most patients. The artefacts produced may seem to reverse on rest images in some cases and may be interpreted as a stressed-induced ischemia. These

artefacts should be kept in mind, and perfusion defects should be identified as such only when they exceed the expected artefactual decrease in activity. As figures 6 and 7 show, these artefacts may look severe if uncorrected. Correction may be done using a prone acquisition or by CT attenuation correction.

Other artefacts include reversible septal defects in patients with left bundle branch block who underwent exercise MPS or had together vasodilator stress with low-level exercise.

Patients with improbably high LV ejection fraction (LVEF) values of 80% to 99% (see dobutamine stress scan sample report) are commonly seen, particularly in those with LV volumes of less than 50 mL (Figure 8). This is a software error and is due to a combination of the poor resolution of SPECT, photon scatter, and the partial volume effect, resulting in very low-end systolic volumes. Some do not report the actual LVEF value, but rather place a disclaimer such as "LVEF > 70%. This of course does not solve the issue since the interpreter is still claiming that the LVEF is greater than 70% when in fact it could be normal at around 60% or so. A more logical way is to put the software generated LVEF value, and a disclaimer that it is artefactually elevated in the LV volume range. The phrase "small heart" should not be used since the heart size is normal.

6.1 Example 1: Attenuation Artefact and Prone Position Imaging

Male patient with very low probability for coronary artery disease.

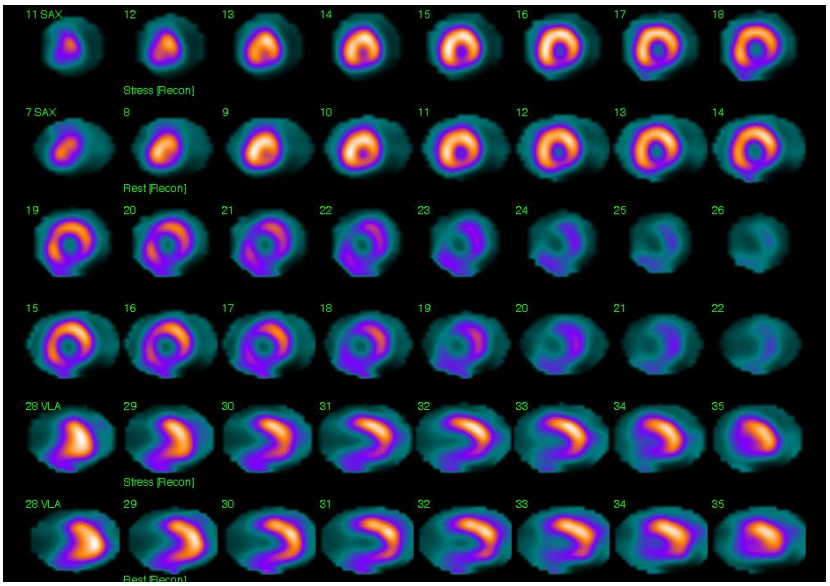


Figure A. In usual supine position showing moderate to severe defects in the inferior segments.

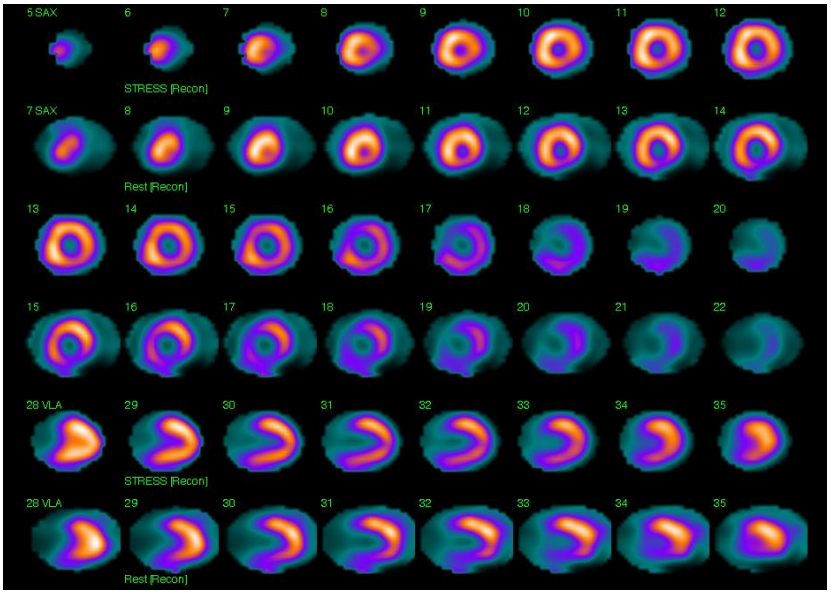
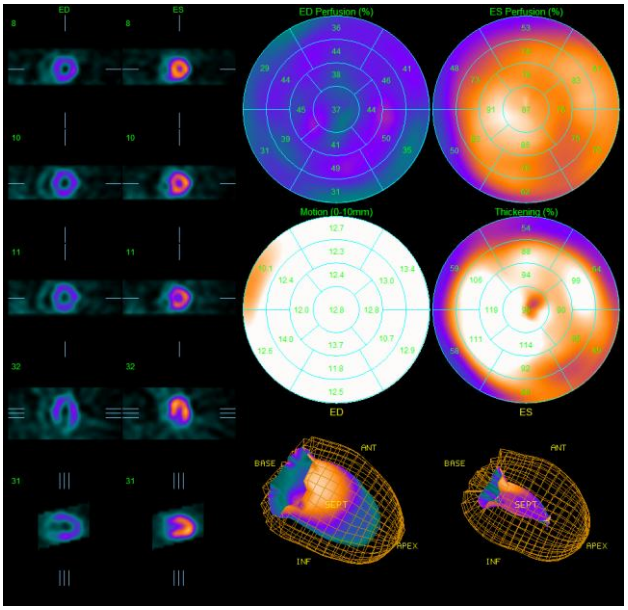


Figure B. Patient in prone position during stress, showing disappearance of the inferior defects, due to attenuation artefact.

This scan was interpreted as normal.

6.2 Example 2: Error in Software Quantification



Type	QGS Stress
Proc ID	Thallium Gated SPECT
View ID	SAX GSP-STR
Date	2014-12-15 11:06:45
Volume	4ml [4]
EDV	47ml [8]
ESV	4ml [4]
EF	92%
Mot Ext	0%, 0cm² [4]
Thk Ext	0%, 0cm² [4]
Eccentricity	0.83 [4]
Matrix	64x64 x 21(z) x 8(t)
Mm/Vox	6.39 x 6.39 x 6.39

Female patient showing very high calculated ejection fraction values using QGS. LV function is normal, and not hyperdynamic.

Scan Findings:

Gated SPECT showed good LV wall motion and thickening.

LV parameters were calculated using Cedars-Sinai QGS software, and showed the following values:

LV End Diastolic Volume = 47 ml

LV End Systolic Volume = 4 ml

LV Ejection Fraction = 92%

Chapter 7: Expected Level of Competence

A nuclear physician should know all the required components and be able to incorporate these into an MPS scan report. A template using structured reporting is recommended.

A knowledge of the normal variants, and common artefacts, is expected. He should be able to identify perfusion defects and describe it in terms of location and severity.

The nuclear medicine physician must be able to correlate the clinical information and the scan indication with the scan findings in order to generate an interpretation that is relevant and answers the clinical question being asked (coronary artery disease / risk stratification and prognosis / significance of a known coronary stenosis / myocardial viability?)

Chapter 8: Sample Reports

8.1 Stress Tc-99m sestamibi myocardial perfusion scintigraphy

Indication:

Evaluation of significance of coronary stenosis.

Clinical information:

62 y/o male. Risk factors include DM and HTN. Presenting with atypical angina. CT coronary angiography shows 60% stenosis of LAD artery.

Procedure:

Gated SPECT MPS was performed 40 minutes after injection of 300 MBq Tc-99m sestamibi at rest. Imaging was also done 15 minutes after injection of 900 MBq at peak treadmill exercise. SPECT reconstruction was performed with and without CT attenuation correction.

Stress ECG report:

Resting 12-lead ECG showed sinus rhythm, normal axis, non-specific ST-T wave changes. The patient underwent treadmill exercise test for 13 minutes and 30 seconds using the modified Bruce protocol (approximate workload of 13.4 METs). Cardiac rate was 73 bpm at baseline and reached a peak of 142 bpm (90% of predicted maximum heart rate). Blood pressure increased from 110/70 mmHg initially, to a maximum of 180/90 mmHg (physiological response). Treadmill exercise was terminated due to fatigue. Post-stress ECG showed non-specific ST-T wave changes with ST depression of 0.5 mm in V3-V6. Post-exercise recovery was uneventful. The ECG portion of the test was negative for exercise-induced ischemia.

Scan Findings:

Stress images: There were mild defects in the basal to apical anterior segments, the midventricular anteroseptal and inferoseptal segments, and the apical septal

segment. The rest of the segments showed normal tracer uptake. The LV was not enlarged.

Rest images: The tracer uptake was normal. Relative to the stress images, there was complete improvement in the defects mentioned.

Gated SPECT:

There was good wall motion and systolic thickening in all LV segments. Calculated LV parameters were as follows:

Stress:	LVEDV = 70 mL	LVESV = 35 mL	LVEF = 50%
Rest:	LVEDV = 71 mL	LVESV = 33 mL	LVEF = 54%

Interpretation:

- Abnormal myocardial perfusion scan.
- Mild, large stress-induced myocardial perfusion abnormality in the anterior and septal segments, consistent with physiologically significant stenosis of LAD artery.
- Adequate LV wall function, but with slight decrease in LVEF post-stress.

8.2 Dipyridamole Tc-99m tetrofosmin myocardial perfusion scintigraphy

Indication:

Risk stratification after myocardial infarction.

Clinical information:

65 y/o female, CAD s/p acute MI 2 months ago. Presenting with easy fatigability and typical angina.

Procedure:

Gated SPECT MPS was performed 30 minutes after injection of 320 MBq Tc-99m tetrofosmin at rest. Imaging was also done 10 minutes after injection of 950 MBq at peak hemodynamic response to dipyridamole infusion. SPECT reconstruction was performed with and without CT attenuation correction.

Dipyridamole stress ECG report:

Baseline 12-lead ECG showed sinus rhythm, normal axis, first-degree AV block. Dipyridamole (38 mg) was infused over 4 minutes. BP ranged from 160/90 mmHg, initially, to a low of 130/80 mmHg. Heart rate was 64 bpm at baseline and reached a peak of 81 bpm. Tc-99m tetrofosmin was injected on the 8th minute after initiation of dipyridamole infusion. No significant dipyridamole-induced ST-segment shifts were noted. Occasional PVCs seen throughout the test. Post-infusion recovery was uneventful. ECG portion of the test was negative for dipyridamole-induced ischemia.

Scan Findings:

Stress images:

Severe labelling defects were seen in the basal to apical anterior segments. Moderate defects noted in the basal to mid anteroseptal and anterolateral segments, and the apex. The other segments showed normal labelling. SSS = 19; SS% = 28%.

Rest images:

The severe defects in the anterior segment were unchanged. There was essentially complete improvement in the anteroseptal and anterolateral segments, and the apex.

SRS = 9; SR% = 13%; SDS = 10; SD% = 15%.

Gated SPECT:

There was depressed wall motion and systolic thickening in the anterior segments. Calculated LV parameters were as follows:

	STRESS	*REST*
End Diastolic Volume	90 mL	85 mL
End Systolic Volume	50 mL	48 mL
Ejection Fraction	44%	44%

Interpretation:

- Myocardial infarct in the anterior segments (3 of 17 segments, 18% LV extent).
- Peri-infarct inducible ischemia in the adjacent anteroseptal and anterolateral segments, and the apex (5 of 17 segments, 29% LV extent).
- Borderline low LVEF, with regional dysfunction in the anterior segments.

8.3 Dobutamine Tc-99m sestamibi myocardial perfusion scintigraphy

Indication:

Assess for aetiology chest pain.

Clinical information:

62 y/o female, presenting with easy fatigability and angina. Unable to exercise because of asthma and COPD.

Procedure:

Gated SPECT MPS was performed 30 minutes after injection of 320 MBq Tc-99m sestamibi at rest. Imaging was also done 10 minutes after injection of 950 MBq at peak hemodynamic response to dobutamine infusion. SPECT reconstruction was performed with and without CT attenuation correction.

Dobutamine stress ECG report:

Baseline 12-lead ECG showed sinus rhythm, normal axis, non-specific ST-T wave changes. Dobutamine was infused at doses of 5, 10, 20, 30 and 40 mcg/kg/minute, increased every 3 minutes. Atropine was not given. Resting heart rate was 70 bpm at baseline and reached a peak of 142 bpm. Tc-99m sestamibi was injected on the last stage of dobutamine infusion (at 40 mcg/kg/minute). There were no significant dobutamine- induced ST segment shifts. Post-infusion recovery was uneventful. The patient experienced mild angina pain by the end of the procedure. The ECG portion of the test was negative for dobutamine-induced ischemia.

Scan Findings:

SPECT images:

Mild, reversible defects were seen in the basal to mid anterolateral and inferolateral segments, and the apical lateral segment.

SSS = 5; SS% = 7%. SRS = 0; SR% = 0%; SDS = 5; SD% = 7%.

Gated SPECT:

There was good wall motion and systolic thickening in all segments. Calculated LV parameters were as follows:

	STRESS	*REST*
End Diastolic Volume	38 mL	55 mL
End Systolic Volume	7 mL	6 mL
Ejection Fraction	82%	83%

*Note: Calculated LVEF values are artefactually elevated, as is commonly seen in this LV volume range.

Interpretation:

- Abnormal dobutamine-stress myocardial perfusion scintigraphy.
- Large, mild stress-induced ischemia in the lateral segments (distribution of LCx artery).
- Good LV wall function.

8.4 Rest-redistribution Tl-201 myocardial perfusion scintigraphy

Indication:

Myocardial viability assessment.

Clinical information:

55 y/o male, CAD s/p acute MI 1 week prior to scan, presenting with CHF.

Procedure:

Gated SPECT MPS was performed 10 minutes after injection of 120 MBq of Tl-201 at rest. Redistribution imaging was done after four hours, and again the following day. SPECT reconstruction was performed with and without CT attenuation correction.

Rest ECG report:

Rest 12-lead ECG showed sinus rhythm, normal axis, PVCs in bigeminy, inferior wall MI of uncertain age.

Scan Findings:

Rest images:

There were severe labelling defects in the basal to apical inferior segments and the basal to mid inferoseptal segments. The rest of the segments exhibited heterogeneous tracer distribution consistent with LV dilatation.

Redistribution images:

Slight improvement seen in the inferoseptal segments at four hours. Complete improvement noted in the inferoseptal defects the following day. The defects in the inferior segments persisted until the end of the study.

Gated SPECT:

There was globally depressed wall motion and systolic thickening, but more severe in the inferior wall. Calculated LV parameters were as follows:

Rest:	LVEDV = 180 mL	LVESV = 126 mL	LVEF = 30%

Redistribution: LVEDV = 185 mL LVESV = 131 mL LVEF = 29%

Interpretation:

- Myocardial infarct in the inferior segments (3 of 17 segments, 18% LV extent).
- Peri-infarct resting ischemia in the adjacent basal to mid inferoseptal segments (2 of 17 segments, 12% LV extent). Late redistribution suggests tight coronary stenosis or collaterals.
- Dilated LV with depressed wall function.

8.5 Alternative Structured Report Templates

RADIOPHARMACEUTICAL: 99mTc Sestamibi, [] Mbq (Rest) / 99mTc Sestamibi, [] Mbq (Stress)

CLINICAL INDICATION

TECHNICAL PROCEDURE AND RESULTS

Stress test:

Protocol - Bicycle	Duration - [] mins.
Peak workload - [] watts.	Work - [] kJ.
Heart rate (bpm): Rest - []	Peak - [] ([]% MPHR)
BP: Rest - []	Peak - []
Reason for termination:	[]
Chest pain - []	

ECG Changes - []

Myocardial Perfusion Scan:

Tomographic images of myocardial perfusion were performed following the injection of 99mTc-Sestamibi at rest and again, following the injection of 99mTc-Sestamibi after stress.

Nitrate administered prior to rest injection - []

OVERALL IMPRESSION

8.6 Other Sample Stress ECG Report Templates

Vasodilator Stress ECG

*Adenosine (58 mg) was infused over 6 minutes. Radiotracer was injected at 3 minutes.

*Dipyridamole (40 mg) was infused over 4 minutes. Radiotracer was injected 7 minutes after the start of dipyridamole infusion.

*Regadenoson (0.4 mg) was given by rapid IV injection, followed by a saline flush. Radiotracer was injected immediately after flushing.

Baseline 12-lead ECG: showed sinus rhythm, normal axis.

Baseline BP: 130/80 mmHg Lowest BP: 110/70

Initial HR: 90 bpm Peak HR: 105 bpm

ST segment change: 1 to 1.5 mm ST depression seen in II, III, aVF.

Arrhythmia: None

Interpretation: ECG is positive for vasodilator-induced ischemia.

Chapter 9: Gated Blood Pool Scans (GBPS)/ Multigated Acquisition (MUGA)

The role of GBPS has decreased in the evolution of echocardiography, but still has a role to play. In the advent of CZT cameras reduced radiation doses and faster acquisition times are now a reality, while the utilization of SPECT allows greater interrogation of individual walls and often assists in evaluating artefacts.

The red blood cells can be labelled by an in vivo, in vitro or modified in vitro technique (details of labelling using Stannous pyrophosphate, heparin and Tc 99mcan be found elsewhere) and imaging performed as either SPECT or planar technique. The latter requires image acquisition in LAO (to calculate LVEF) +/- caudal tilt, anterior and left lateral or LPO positions so that all walls can be reviewed. The right ventricle should also be reviewed qualitatively. For an accurate RVEF, a first pass acquisition in RAO view or SPECT is required. The first pass study can also be used to evaluate for left to right shunt (Qp/Qs) using lung recirculation algorithms.

As opposed to echocardiography, CT, MRI, MPS SPECT and angiography, the GBPS offers a volume based method to calculate ejection fraction, and is often the easiest technology to reproduce for a reliable, accurate LVEF. The volumes are proportional to the radiation count (background corrected) at end diastole and end systole.

EF = End-diastolic counts – End systolic counts / End diastolic counts.

9.1 Indications

1. Reproducing an accurate EF (oncological studies, assessment for an AICD or cardiac transplant)
2. When echocardiographic images are suboptimal
3. Assessing for a left to right cardiac shunt
4. With exercise – congenital heart disease. Some valvular heart disease (e.g occasionally aortic regurgitation severity). Its previous role to assess for reversible ischaemia has been

largely superceded by MPS, stress echocardiography and stress MRI

9.2 Reporting

As with MPS, a clinical indication should be given (< 2 lines).

The report should include the technique used (eg in vitro labelling) and the dose administered.

There should be a qualitative assessment of RV and LV size and function, both globally and segmentally and comparison made to prior imaging. The LV (at least) should be reported quantitatively, with LVEF and, in brackets, the normal range (e.g. LVEF normal > 50 %, depending on the institution's normal range)

The time activity curve, including filling rates, should be reviewed to consider options such as diastolic dysfunction (HFpEF). Cardiac volumes may be reported, depending on the institution's preferences.

9.3 Conclusion

This should include whether the study is normal or abnormal, the degree of cardiac dysfunction (e.g >50 % = normal, 40-50 % = mild LV dysfunction, 30-40 % = moderate LV dysfunction and < 30 % = severe LV dysfunction) and a direct comparison to previous studies, if relevant. The absolute value for LVEF should be repeated in the conclusion. Urgent or unexpected results should be communicated to referrers ASAP by telephone.

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