REVIEW ARTICLE—EDUCATIOAL TRACK

Improving Quality of Clinical Diagnosis Report with Single-Photon Emission Computed Tomography Myocardial Perfusion Imaging and Coronary Computed Tomography Angiography

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Abstract

Non-invasive cardiac imaging modalities including single-photon emission computed tomography myocardial perfusion image (SPECT-MPI) and coronary computed tomography angiography (CTA) have been widely used for diagnosis of coronary artery disease (CAD). The American Society of Nuclear Cardiology and Society of Cardiovascular Computed Tomography have recently published the guidelines for the instrumentation, acquisition, processing, interpretation, as well as reporting of SPECT and coronary CTA. These guidelines have highlighted and well documented how the imaging reporting influences medical practice for physician and treatment care for patients, suggesting that cardiac imaging reports for interpretation for patient management. This review article here summarizes improving quality of cardiac imaging reports by SPECT-MPI and coronary CTA.

Keywords: Coronary artery disease, Coronary computed tomography angiography, Reporting, Single-photon emission computed tomography myocardial perfusion imaging
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Cardiac imaging reports should provide a basic bottom line results to the referring physician and must be clear and concise. The standard components of structured reporting include administrative information, patient demographics, study referral data, history and risk factors, study description, study findings, and other reporting parameters (1). Many different structured reports can be generated from a set of structured data. The potential reports can include a clinical patient-specific report, summary quality report, billing report, reporting the data to registries, and other reports as need. Therefore, some data elements are required for certain acquisitions and clinical indications, while some may be optional or irrelevant for other indications (2).

Single-photon emission computed tomography myocardial perfusion imaging (SPECT-MPI)

The American Society of Nuclear Cardiology has published a new guideline for the reporting of SPECT-MPI in 2017 (2). The guideline was updated and expanded to include a broader perspective of nuclear cardiology practice. The guideline emphasized the need for a defined structure containing standardized data elements to facilitate utilization of the complex data contained in an imaging report into the integrated healthcare of the patient through the electronic health record. The structured report is also an integral part to define quality in nuclear cardiology practices. There continues to be interest in the implementation of structured reporting as a mechanism to improve quality and outcomes and to reduce cost in fulfillment of the triple aim (2). The structured report should be made at the point that the result utilization has focused on how the referring physician incorporates the report data to affect patient management and the differences between the referring physicians approach and the imaging physicians anticipated response to the report (3). Important documents were utilized in the development of nuclear cardiology MPI reporting standard. The American College of Cardiology “Heath Policy Statement on Structured Reporting and Cardiovascular Imaging”, the “Key Data Elements and

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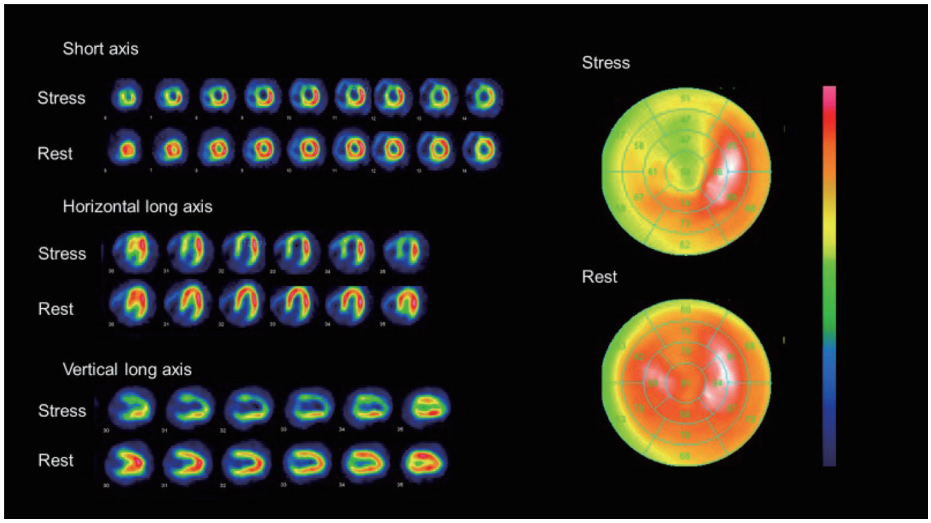
EXAM: SPECT-MPI

Report of exercise myocardial perfusion and function
Reason for study: 69-year-old male with shortness of breath.
Clinical History: He has a history of hypertension and dyslipidemia. He has not had prior coronary angiography and has a SPECT myocardial perfusion imaging study.
Cardiac medication: aspirin, clopidogrel, atorvastatin,
Duration of exercise: 14min. 3s. PROTOCOL: Bruce
Reason for termination: ST depression with chest oppression
Vital signs: Resting HR: 65 bpm. BP: 121/66 mmHg
Peak stress HR: 110 bpm. BP: 178/103 mmHg
Percent maximum HR: 86%
ECG: Resting: Normal sinus rhythm.
Exercise: Significant ST segment depression in II, III, aVF, V4-6 during exercise. Exercise induced chest oppression.
Technical factors: Good quality gated tomographic myocardial perfusion images acquired using a double head gamma camera without attenuation correction. Technetium-99m tetrofosmin was administered intravenously at peak stress 296 MBq and at rest 740 MBq. Artifact: None.
Perfusion Comments
Post stress images demonstrate a moderate to severe reduction in tracer uptake in the anteroseptal wall to apical wall segments with significant improvement on the rest imaging. This is consistent with a large area of moderate to severe ischemia in the left anterior descending artery territory.
Function Comments: Normal LV ejection fraction. Normal LV cavity size.
POST-STRESS: Moderate hypokinesis of the anteroseptal wall to apical wall segments which is compatible with post ischemic stunning.
REST: Ejection fraction 59 %, LVEDV 90ml, LVESV 37ml
POST-STRESS: Ejection fraction 69 %, LVEDV 83ml, LVESV 26ml
TID Ratio: 1.08 (Normal <1.2)

Interpretation Summary
1. The stress electrocardiogram was positive for electrocardiographic evidence of myocardial ischemia.
2. The Duke Treadmill Score was intermediate risk at 5.
3. The patient developed typical angina at peak stress.
4. LV perfusion suggest moderate to severe ischemia in the left anterior descending artery territory.
5. LV function suggest post ischemic stunning at the left anterior descending artery territory.

Management and recommendations:
Invasive angiography and revascularization should be considered.



Definitions for Cardiac Imaging: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Data Standards" and the European Association of Nuclear Medicine and the European Association of Cardiovascular Imaging remain as sentinel documents and facilitate the reporting of imaging studies in multimodality environments.

The overall impression is the most important portion of the nuclear cardiology report, as it assimilates and summarizes the most important details presented in the preceding sections. Summaries of LV perfusion, function, and viability should be provided with clear indication of normal vs abnormal findings. For perfusion defects, a statement of whether these findings indicate ischemia, infarction, or both should be provided. The

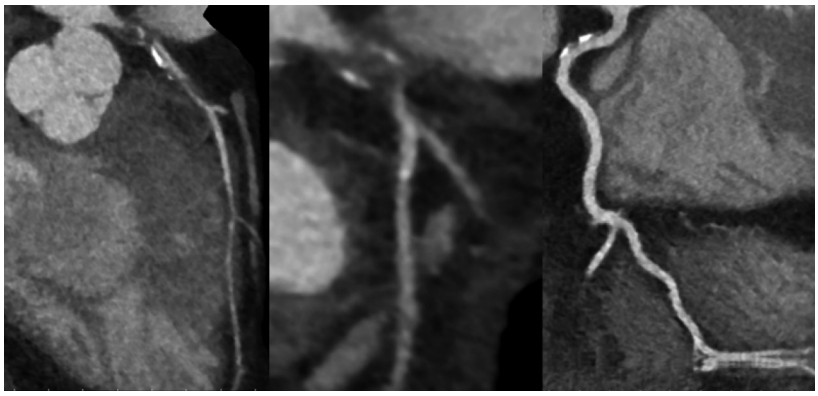
EXAM: Coronary CT angiography with coronary calcium scoring

Indication: Typical Chest pain
Risk Factors: Hypertension, Current smoking

Procedure: Using ×× (scanner name), a non-contrast study followed by a contrast study were performed. Patient was given oral β-blocker (name and dose) and (0.4mg or 0.8mg) nitroglycerin prior to contrast injection. (Prospective or Retrospective) ECG triggering was used. There were no complications. The technical quality is Excellent.

Findings: The coronary system is right dominant.
The left main coronary artery demonstrates severe stenosis (≥70%) with vulnerable plaque. The left main artery bifurcates into the left anterior descending coronary artery and the circumflex artery.
The left anterior descending coronary artery shows severe stenosis (≥70%) with severe partially calcified plaque in the proximal left anterior descending coronary artery.
The left circumflex coronary artery shows mild disease (<25%) with calcified plaque.
The right coronary artery shows mild disease. Proximal right coronary artery (<25%) with moderate mixed plaque.

There are no thickness/calcifications in the aortic and mitral valves. The left ventricle is of normal size, wall thickness. The left atrium, right ventricle and right atrium are normal. The pericardium, mediastinum and aorta are normal as are the remainder of the cardiac structures.



Impression:
1. Coronary calcium score: 212 Agatston Score
2. Severe stenosis in left main and the proximal left anterior descending coronary artery by coronary CT angiography
3. CAD-RADS 4B/V

Management and recommendations:
Consider hospital admission with cardiology consultation. Invasive coronary angiography and revascularization should be considered if clinically appropriate.

number of coronary territories involved and possibly even specific vessel territories can be indicated, though caution should be advised in correlating perfusion results to coronary anatomy in the absence of prior invasive or CT coronary angiography to precisely define the epicardial distributions (2).

Coronary computed tomography angiography (CTA)

Imaging artifacts have been progressively decreased due to recent technologies, however, further novel analyses of coronary CTA such as automated physiological assessment or segmentation of coronary tree for plaque require to maintain image quality (4,5). The Society of Cardiovascular Computed Tomography (SCCT) has recently updated the interpretation and reporting of coronary CTA, highlighting the standardization of protocol and reports of coronary CTA (6). The assessment of coronary artery stenosis by curved multiplanar reformation image (MPR) is optimal, whereas the assessment by axial image, MPR, maximum intensity projection image is also recommended. All image quality should be reported in the reports. The SCCT also updated an expert consensus document for the coronary artery disease reporting and data system (CAD-RADS) (7). Similar with SPECT-MPI images, the purposes of the document were to standardize their reporting system in order to consistently provide the standardization of the patient management to referring physicians based on the study results. The society has strongly recommended physicians to use the CAD-RADS terminology to maintain the quality of the study results and to standardize patient management. Of importance, the documents guide to provide medications or downstream testing based on CAD-RADS. Preventive medications such as statin and/or aspirin

Table 1 Components of the structured report

	SPECT-MPI	Coronary CTA
Administrative Information	Patient name, Date of birth, Age, Sex Patient ID, Date of study,	
Risk Factors and clinical demographics	1. Coronary risk factors, Cardiac event history including history of revascularization 2. Demographics: Lab data, Blood pressure, Heart rate	
Study Description	1. Indication: Reason for study (e. g. Symptom [Typical/atypical/non-cardiac chest pain, dyspnea], Preoperative study) 2. (Single/2 day) Rest/Stress (or Stress/Rest) Exercise/Pharmacologic stress myocardial perfusion imaging with LV function analysis 3. Technique (The isotope used for imaging, Rest imaging was after an injection of X mCi. The patient underwent exercise tredmill/bike stress testing according to the X protocol, exercising for X minutes, achieving a workload of X metabolic equivalents (METS). Pharmacologic stress testing was performed with adenosine/dipyridamole/dobutamine/regadenoson at a rate of X for X minutes. Stress imaging was performed after an injection of X mCi, The stress ECG showed (no) ST-segment changes consistent with myocardial ischemia, The Duke Treadmill score was X. All imaging was performed on a X camera and data were analyzed using X software.) 4. Image quality (poor/fair/good/excellent)	1. Indication: Reason for study (e. g. Symptom [Typical/atypical/non-cardiac chest pain, dyspnea], Preoperative study) 2. Technique (Scanner type, non-contrast CT for coronary artery calcium, contrast coronary CTA, collimation images, 3-dimentional reconstructions including curved multiplanar reformat imaging) 3. Acquisition (Prospective or retrospective ECG gating study) 4. Medications (β -blockades and sublingual nitroglycerine) 5. Image quality (Excellent, good, fair, poor, unevaluable)
Study Findings	1. Perfusion comments (Myocardial perfusion imaging is normal with no evidence of ischemia or scar OR Myocardial perfusion imaging is abnormal with a small/moderate/large area of ischemia/infarction in the distribution of the X artery) 2. Function comments (Left ventricular systolic function is normal/abnormal with (no)/X regional wall motion abnormalities. Left/Right ventricular hypertrophy/dilatation is present)	1. Coronary artery dominance (Right/Left/Co- coronary artery dominance) 2. Stenosis severity per segment (0%, 1-24%, 25-49%, 50-69%, 70-99% and 100%) 3. Plaque type per segment per segment (No-calcified, calcified, partially calcified or vulnerable/high risk plaque including low attenuation plaque<30 hounsfield unit, positive remodeling, spotty calcification and the napkin ring sign) 4. Other cardiac findings (e. g. cardiac valves, pericardium, myocardium, cardiac chambers) 5. Extra cardiac findings (e.g. Pulmonary nodule, pulmonary embolization, arterial dissection)
Interpretation summary	1. The result of stress electrocardiogram 2. The Duke Treadmill Score 3. The symptom of the patient at the peak stress 4. LV perfusion comments. 5. Function comments	1. Total calcium score 2. Evidence or no-evidence of coronary atherosclerosis 3. CAD-RADS 4. Further cardiac investigation (None, consider and/or recommend functional assessment, invasive coronary angiography or viability assessment, additional or alternative evaluation if non-diagnostic study) 5. Management (Reassurance, consider and/or recommend preventive therapy, risk factor modification, symptom-guided anti-ischemic pharmacotherapy or revascularization) 6. Others

SPECT-MPI: Single-photon emission computed tomography myocardial perfusion imaging, CTA: Computed tomography angiography, ECG: Electrocardiogram, CAD-RADS: Coronary artery disease-Reporting and data system

are recommended for patients with ≥25–49% stenosis (CAD-RADS 2), since non-obstructive coronary atherosclerosis is known to be associated with worsen mortality risk (8). Recent data suggested that coronary CTA is associated with lower cardiovascular risk compared to standard of patient management due to increased use of preventive medications (9). Another important point is that patients with CAD-RADS 3 (50–69% stenosis) is recommended to perform functional tests, but not invasive coronary angiography (ICA), in order to investigate the vessels. ICA is, therefore, considered when CAD-RADS 4 and 5 (patients with >70% stenosis). In addition, when CAD-RADS 4, if patients don't have >50% stenosis in left main nor 3 vessel disease, the guidelines suggest performing functional tests. In this regard, these recommendations suggest to avoid unnecessary downstream testing, resulting in the reduction of ICA and coronary interventions. Table 1 summarizes how to report SPECT-MPI and coronary CTA findings.

Conclusions

Both new imaging guidelines on clinical diagnostic reports were developed based on well-validated clinical evidences. The guidelines have now educated the referring physicians to improve and standardize the reporting for patient management. The standardization of patient management based on SPECT-MPI and coronary CTA results will allow to improve patients outcomes and may develop the diagnostic pathway by physicians and technologies such as artificial intelligence. Available and evolving technology solutions such as structured reporting software, decision support tools and machine learning may ameliorate the burden of comprehensive imaging reporting and future enhance the value of the report in providing diagnostic, prognostic, and decision-guiding information. Using these technology tools could facilitate evidence-based and patient-centered reporting in the future.

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Conflicts of interest

None.

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