Intracoronary $^{99m}$Tc-Sestamibi Single Photon Emission Computed Tomography/Computed Tomography for Preoperative Evaluation of At-Risk Myocardium

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A 73-year-old man with a history of previous coronary artery bypass surgery (left internal mammary artery [LIMA]–to–first obtuse marginal artery graft, right internal mammary artery–to–left anterior descending artery graft, and venous graft to second obtuse marginal branch) and previously treated melanoma and gastric carcinoma was referred for evaluation of an enlarging lung mass adjacent to a vascular graft on computed tomography (CT). CT coronary angiography confirmed that the suspicious left upper lobe lung mass was encasing the LIMA graft (Figure 1). 18F-fluorodeoxyglucose positron emission tomography/CT study confirmed isolated, intense metabolic activity within the lesion consistent with malignancy (Figure 2). Echocardiography confirmed normal left ventricular systolic function. A decision for surgical resection was made, with the need for further evaluation of the coronary circulation to assess the implications of potential sacrifice of the LIMA graft. At the time of coronary angiography (Figure 3), 76 MBq $^{99m}$Tc-sestamibi was injected directly into the LIMA graft to establish the area of viable myocardium perfused by this vessel. Single photon emission CT/CT imaging performed 1 hour later (Figure 4) demonstrated that, at most, sacrifice of the LIMA graft would result in only a small infarct of the lateral wall. Subtraction of these images from rest myocardial perfusion scintigraphy performed 24 hours later (Figure 5) with semiquantitative display on a polar map (Figure 6) confirmed that the LIMA territory was only a small portion of the myocardium. The presence of collaterals would further reduce the infarct size if the LIMA were to be euthanized. Incidentally, the lung nodule appeared to be $^{99m}$Tc-sestamibi avid.

The patient subsequently underwent video-assisted thoracic surgical wedge resection of the left upper lobe lesion without complication. Pathology confirmed a moderately differentiated adenocarcinoma of gastric origin invading the epicardial fat with coronary vascular and perineural invasion. The patient remains well 2 months postoperatively without cardiac compromise.

$^{99m}$Tc-sestamibi is a lipophilic cation with high first-pass myocardial uptake without significant redistribution. Scintigraphy after intracoronary injection of $^{99m}$Tc-sestamibi has been used to define the myocardial area perfused by a specific coronary artery, for evaluation of the functional significance of a coronary stenosis, and for assessment of myocardial viability after percutaneous transluminal coronary angioplasty. Intravenous injection of $^{99m}$Tc-sestamibi during balloon occlusion of the LIMA graft was considered an alternative method for assessing the myocardium at risk (and accounting for collateral flow) but was deemed an unacceptable risk to the patient.

It is notable that the tumor was highly $^{99m}$Tc-sestamibi avid for 3 reasons. $^{99m}$Tc-sestamibi uptake in indeterminate lung nodules after intravenous injection has a positive predictive value of 91% for malignancy, and although the injection in this case was intra-arterial, it supports the need for resection of this nodule as potentially malignant. Increased $^{99m}$Tc-sestamibi uptake has also been prospectively shown to predict response to chemotherapy in unresectable lung cancer, with greater $^{99m}$Tc-sestamibi uptake and retention within the tumor indicative of inhibition of the efflux transport function of multidrug resistance–related P glycoprotein. It also confirms that the blood supply of the tumor has arisen directly from a coronary vascular graft.

This unique case demonstrates the complementary role of modern cardiovascular imaging techniques and the ongoing selective role of intracoronary $^{99m}$Tc-sestamibi single photon emission CT/CT imaging for individual coronary artery perfusion. It also highlights the significance of $^{99m}$Tc-sestamibi uptake in lung lesions (incidental or otherwise) as an indicator of malignancy.

Disclosures

None.

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(Circulation. 2013;128:567-570.)

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Circulation is available at http://circ.ahajournals.org

DOI: 10.1161/CIRCULATIONAHA.113.001417
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Figure 1. Multiplanar reformatted image of a computed tomography coronary angiogram (dose-length product=625) demonstrating a 2.3-cm left upper lobe nodule (asterisk) inseparable from and likely invading mediastinal fat. The left internal mammary artery-to-first obtuse marginal graft (arrow) is intimately related to the medial portion of the nodule. Visible vasculature is noted within the nodule.

Figure 2. After intravenous injection of 365 MBq 18F-fluorodeoxyglucose, emission tomographic images were acquired with low-dose computed tomography performed for attenuation correction and anatomic localization. Maximum-intensity projection (left) and transverse (right) images demonstrate isolated, intense metabolic activity within the left upper lobe lung mass, consistent with malignancy. No other definite metabolically active lesion to suggest other metastasis was seen.
Figure 3. Coronary angiography demonstrates that the left internal mammary artery (LIMA) graft to the first obtuse marginal branch (OM1) is widely patent, with no evidence of obstruction or external compression. The OM1 branch supply has a relatively small distribution. Other coronary grafts appeared patent. Thin arrow indicates OM1; thick arrow, LIMA graft.

Figure 4. Single photon emission computed tomography (CT)/CT images were acquired 1 hour after injection of 76 MBq 99mTc-sestamibi into the left internal mammary artery (LIMA) graft. Identification of uptake within the tumor and left ventricle was possible only by comparison to the coregistered CT (dose-length product=65) also used for attenuation correction. A. A focal area of perfusion to a small region of the midlateral wall of the left ventricle (thin arrow), consistent with the myocardial territory of the LIMA-first obtuse marginal branch (OM1) graft. No tracer uptake is seen elsewhere within the myocardium. B. A focal area of uptake within the adjacent left upper lobe tumor (thick arrow), confirming methoxy-isobutylisonitrile avidity and blood supply by the LIMA graft that it encases. Thin arrow indicates myocardial territory of the LIMA-OM1 graft; thick arrow, tumor.
Figure 5. Single photon emission computed tomography (SPECT) myocardial perfusion scintigraphy was acquired in the supine position with CT attenuation correction performed with the previously obtained CT image after intravenous injection of 326 MBq 99mTc-sestamibi at rest (rows 1 and 4). The top 3 rows represent the horizontal long axis; the bottom 3 rows, the short axis. These images were manually coregistered with the left internal mammary artery (LIMA) intracoronary SPECT (rows 2 and 5) using CT landmarks. Digital subtraction of the LIMA intracoronary SPECT from the resting SPECT identified the worst-case scenario for myocardial infarction (rows 3 and 6) from sacrifice of the LIMA graft in the absence of collaterals.

Figure 6. The rest and intracoronary single photon emission computed tomography data were processed with 4D-MSPECT (Invia Medical Imaging Solutions, Ann Arbor, MI) to semiquantitatively display the myocardium at risk in a polar map.
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Circulation. 2013;128:567-570
doi: 10.1161/CIRCULATIONAHA.113.001417

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