Clinical Usefulness of Dual-Energy Cardiac Computed Tomography in Acute Coronary Syndrome Using a Dual-Layer Spectral Detector Scanner

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An 80-year-old woman visited a local hospital because of exertion-induced chest discomfort that lasted several minutes. Although no significant ST-segment changes were observed in an ECG, her troponin-I levels were high. Thus, she was suspected of having ischemic heart disease and was transferred to our university hospital. She had a history of hypertension and was taking antihypertensive drugs, but there had been no chest symptoms. She had no symptoms at the time of visit, no abnormality in her vital signs, and no abnormal findings on physical examination. An ECG obtained after admission revealed no ST-segment changes (Figure 1). Transthoracic echocardiography showed good left ventricular systolic function and no wall motion abnormality. All cardiac enzyme levels were normal, except for the troponin-T level (0.368 ng/mL). We considered acute coronary syndrome or cardiomyopathy and decided to perform imaging evaluations. She underwent cardiac computed tomography (CT) imaging using a dual-layer spectral detector CT (IQon Spectral CT; Philips Healthcare, Best, The Netherlands). Standard coronary CT angiography was performed with intravenous infusion of 550 mg iodine/kg of iodinated contrast medium (iodine 370 mg/mL) for a period of 20 s. After coronary CT angiography, late iodine enhancement (LIE) imaging was performed 8 minutes after the contrast injection. Coronary CT angiography showed severe stenosis of the first diagonal branch (Figure 2A). For more confidence in the diagnosis, we immediately performed retrospective dual-energy analysis using LIE imaging data with a thin-client workstation (Spectral Diagnostic Suite; Philips Healthcare). Virtual monochromatic images at 50 keV clearly showed focal hyperenhancement in the midanterolateral wall corresponding to the first diagonal branch territory, which indicated infarcted myocardium (Figure 2B). Quantitative analysis with an iodine density map revealed an iodine content of 2.0 mg/mL in the hyperenhanced segment and an iodine content of 1.2 mg/mL in the remote unaffected myocardial segment (Figure 2C). To create a myocardial extracellular volume (ECV) map, iodine density map images were analyzed on a postprocessing workstation (Ziostation 2; Ziosoft, Tokyo, Japan). The ECVs of the affected and remote unaffected segments were 46.4% and 28.2%, respectively, which indicated severe myocardial damage in the infarcted segment (Figure 2D and 2E). The dual-energy analysis for LIE and ECV assessments requires a processing time of ≈5 minutes of nearly a real-time evaluation. We diagnosed acute myocardial infarction in the diagonal branch region with high confidence levels. On the next day, cardiac magnetic resonance imaging was performed on a 3.0-T magnetic resonance imaging scanner (Ingenia 3.0 T; Philips Medical Systems) to confirm the exact extent of the infarcted myocardium. Transmural lateral late gadolinium enhancement was noted in the midanterolateral wall. This area showed high intensity in T2-weighted black blood images (Figure 3A and 3B). The ECVs calculated from T1 mapping before and after gadolinium-based contrast administration for the affected and remote unaffected segments were 49.2% and 28.6%, respectively (Figure 3C). These cardiac magnetic resonance imaging findings confirmed acute myocardial infarction in the diagonal branch territory and were similar to the dual-energy cardiac CT results. We performed cardiac catheterization and coronary angiography on a standby basis 2 days after her first visit. Although 90% stenosis of the diagonal branch bifurcation, no significant stenosis of the other coronary arteries was observed (Figure 4). The fractional flow reserve test of the left anterior descending artery showed a result of 0.85. Because there was a possibility of the plaque shifting to the left anterior descending artery during percutaneous coronary intervention for the diagonal branch lesion, and moreover, she had no symptoms and small infarcted area, we decided to increase drug therapy without percutaneous coronary intervention. For cases suspected of acute coronary syndrome, emergency coronary angiography is performed to achieve early coronary reperfusion. Therefore, in cases of angiography with no coronary artery occlusion and stenosis alone, revascularization is often performed only by contrasting judgment without evaluating myocardial ischemia. In this case, dual-layer spectral detector CT was used to not only identify the site of anatomic stenosis of the coronary artery but also evaluate the myocardial infarcted area, and it provided information that was almost similar to cardiac magnetic resonance imaging data. In emergency settings, coronary

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CT angiography is widely used because of its accessibility and fast acquisition time, unlike cardiac magnetic resonance imaging.[1,2] Currently, coronary CT angiography is indicated in patients with acute chest pain associated with an inconclusive diagnosis.[1] In this situation, immediately obtaining the information on the presence of myocardial infarction and the infarcted area and location, in addition to the conventional anatomic information of coronary artery lesions, by this new CT technology could support clinical decision making for patient management. Therefore, LIE and ECV assessments accompanied with coronary CT angiography using a dual-layer spectral detector CT scanner can be useful for the noninvasive evaluation of acute coronary syndrome. To our knowledge, this is the first patient with acute coronary syndrome, who underwent LIE and ECV imaging performed with dual-layer spectral detector CT, which has recently become commercially available.

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Disclosures

None.

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Key Words: acute coronary syndrome ■ computed tomography angiography ■ extracellular matrix ■ magnetic resonance imaging ■ percutaneous coronary intervention

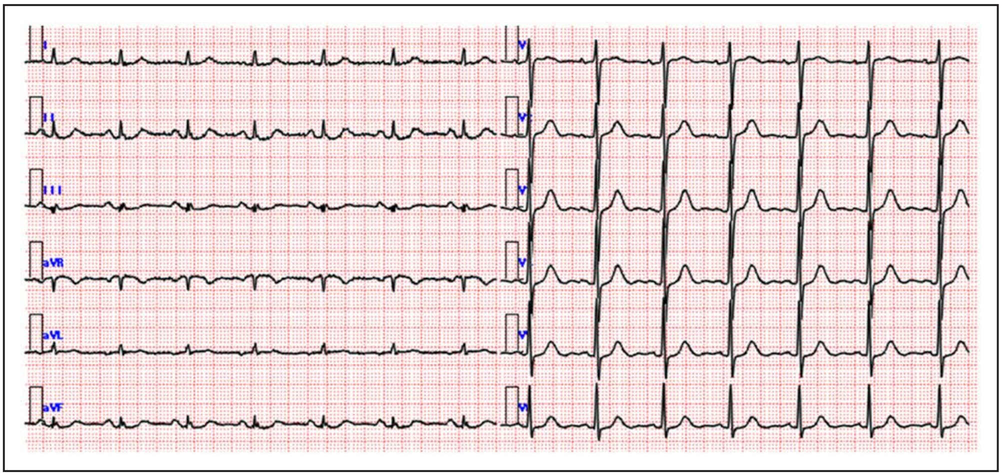

Figure 1. ECG obtained at our emergency department shows no ST-segment changes.

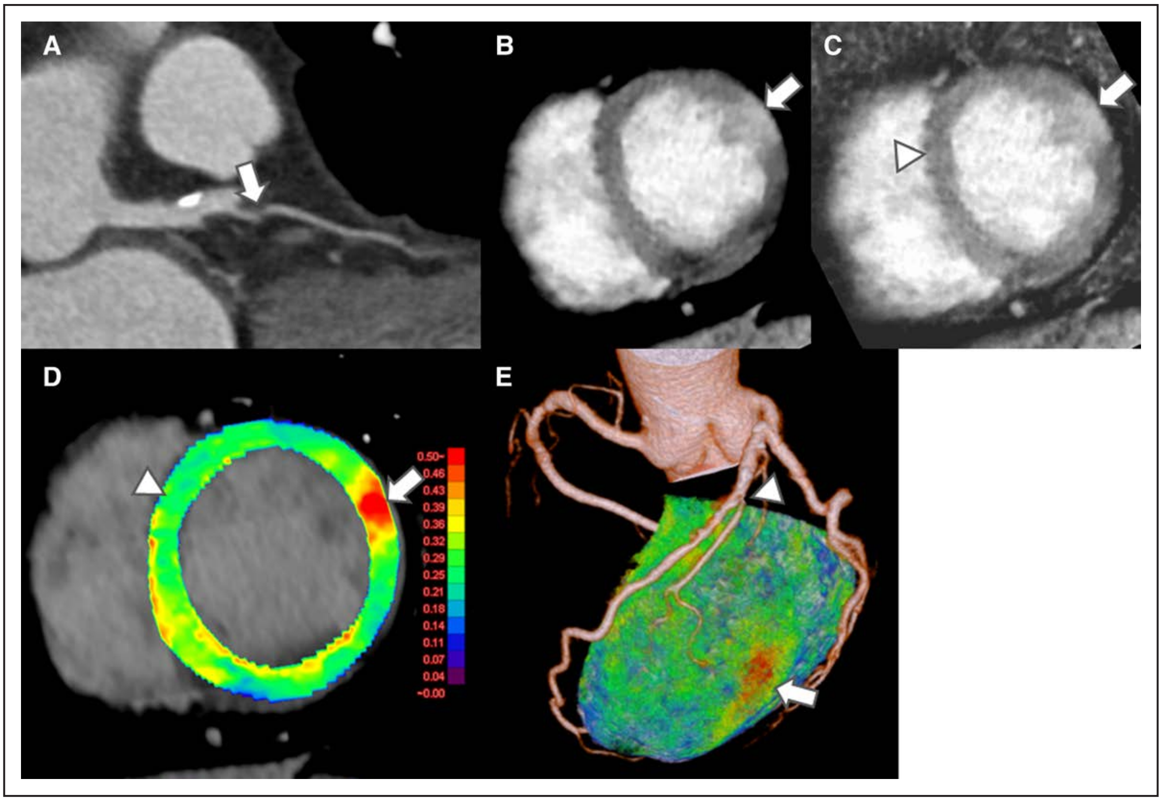

Figure 2. Coronary computed tomography (CT) angiography shows severe stenosis of the first diagonal branch (arrow; **A**). Virtual monochromatic images at 50 keV show late iodine enhancement in the midanterolateral wall (arrow) corresponding to the first diagonal branch territory (**B**). Iodine density map shows an iodine content of 2.0 mg/mL in the affected segment (arrow) and an iodine content of 1.2 mg/mL in the remote unaffected myocardial segment (arrow head; **C**). Myocardial extracellular volume (ECV) of the affected (arrow) and remote unaffected (arrow head) segments were 46.4% and 28.2%, respectively (**D**). Three-dimensional CT extracellular volume (ECV) map/coronary CT angiography fusion imaging (**E**) clearly shows the anatomic relationship between the coronary artery lesion (arrow head) and the infarcted area (arrow).

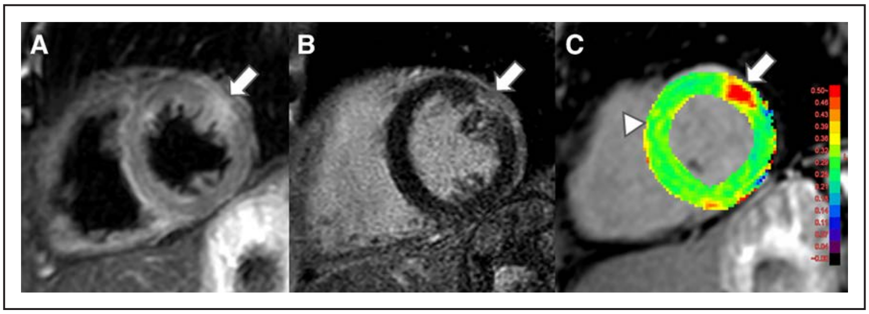

Figure 3. Cardiac magnetic resonance imaging showed high intensity in the midanterolateral wall in a T2-weighted black blood image (arrow; **A**). The area shows transmural lateral late gadolinium enhancement (arrow; **B**). Myocardial extracellular volumes calculated from T1 mapping of the affected (arrow) and remote unaffected (arrow head) segments were 49.2% and 28.6%, respectively (**C**).

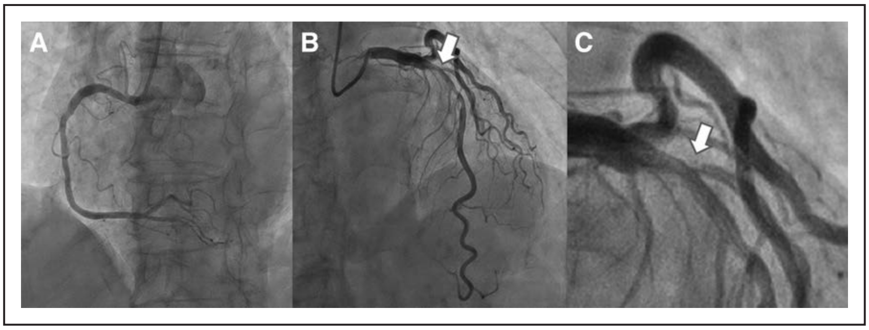

Figure 4. Coronary angiography on a standby basis 2 days after the visit. No stenosis of the right coronary artery is observed (**A**), whereas 90% stenosis of the diagonal branch bifurcation is observed (arrow; **B**, **C**).

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