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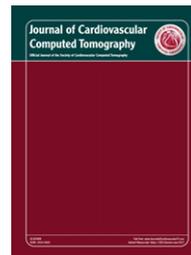
Images in Cardiovascular CT

A low-dose comprehensive cardiac CT protocol assessing anatomy, function, perfusion, and viability

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ARTICLE INFO

ABSTRACT

Radiation exposure in cardiac imaging is a major healthcare concern and low-dose cardiac imaging has important implications for patients. We describe the application of a low-dose comprehensive cardiac computed tomography protocol that assesses anatomy, function, perfusion and viability with correlations to invasive coronary angiography and magnetic resonance imaging.

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A 69-year-old woman with chest pain underwent computed tomography (CT) with the use of a 320-multidetector scanner (Aquilion ONE; Toshiba Medical Systems, Tustin, CA, USA). The comprehensive cardiac protocol included coronary calcium scan (140-mm z-axis, 120 kV, 160 mA), rest coronary CT angiography (CTA; 120-mm z-axis, 100 kV, automated tube current selection of 80 mA), 50 mL of iodinated contrast [Iomeron 400; Bracco, Milan, Italy]; half-segment reconstruction, 70%–80% acquisition), adenosine stress coronary CTA (80-mm z-axis to cover only the left ventricle, 100 kV, tube current of 110 mA, 50 mL of iodinated contrast, half-segment reconstruction, images acquired across one cardiac cycle), and delayed enhancement (5 minutes, 80-mm z-axis, 80 kV, 110 mA). The heart rate was 45 beats/min during the rest coronary CTA and 67 beats/min during the stress coronary CTA. Images were reconstructed with an iterative reconstruction algorithm. A reconstruction kernel with a beam hardening correction algorithm (FC03) was used to assess perfusion images.[1] Stenoses were identified in left anterior descending (LAD), first diagonal, and left circumflex (LCX) arteries and confirmed by invasive coronary angiography (Fig. 1). Stress imaging identified reversible defects in LAD and LCX territories (Fig. 2; Supplemental
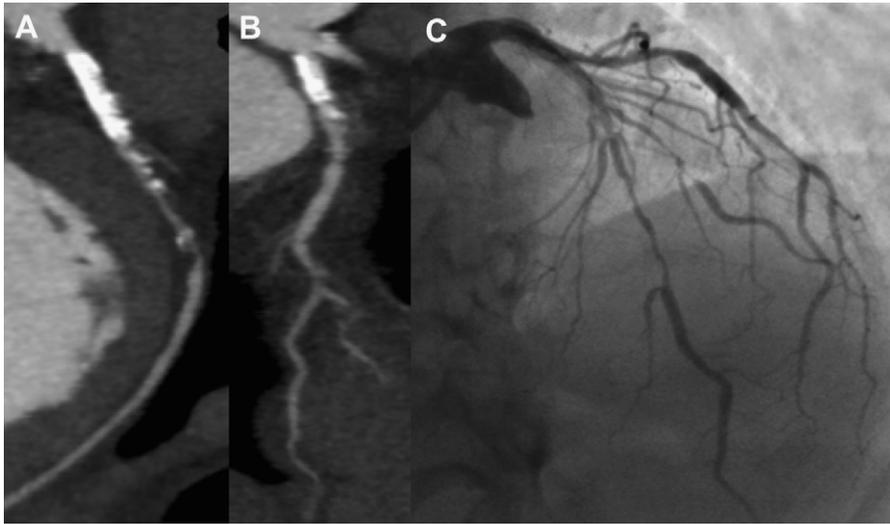
Figure 1 – Computed tomography coronary angiography (A and B) and invasive coronary angiography (C) images show stenoses in the left anterior descending, first diagonal, and left circumflex arteries.
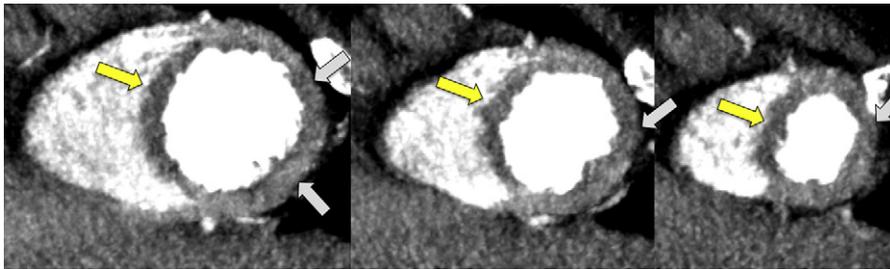

Figure 2 – Short-axis views of the left ventricle during adenosine stress show hypo-enhancement in the territory of the left anterior descending artery (*yellow arrows*) and left circumflex artery (*gray arrows*).
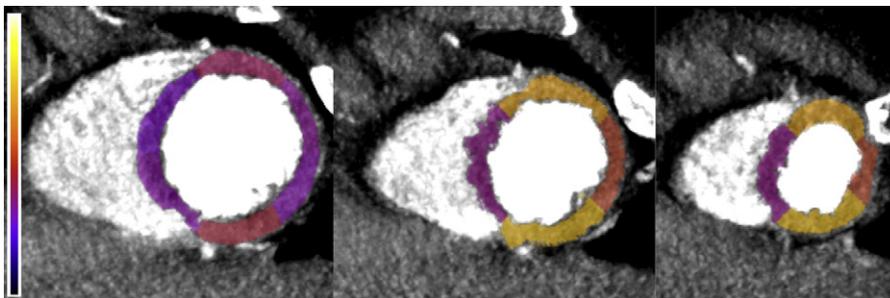

Figure 3 – With the use of automated software (Vitrea fX 6.0; Vital Images, Minnetonka, MN, USA) the transmyocardial perfusion ratio for each of the 17 myocardial segments was calculated by dividing the subendocardial by the subepicardial attenuation density.[1] Normal areas are shown in yellow/orange, and abnormal areas are highlighted in purple/blue. The transmyocardial perfusion ratio during adenosine stress is shown superimposed on short-axis views of the left ventricle. A color-coded bar on the left shows the range of transmyocardial perfusion ratios from black (0.5) to white (1.5).
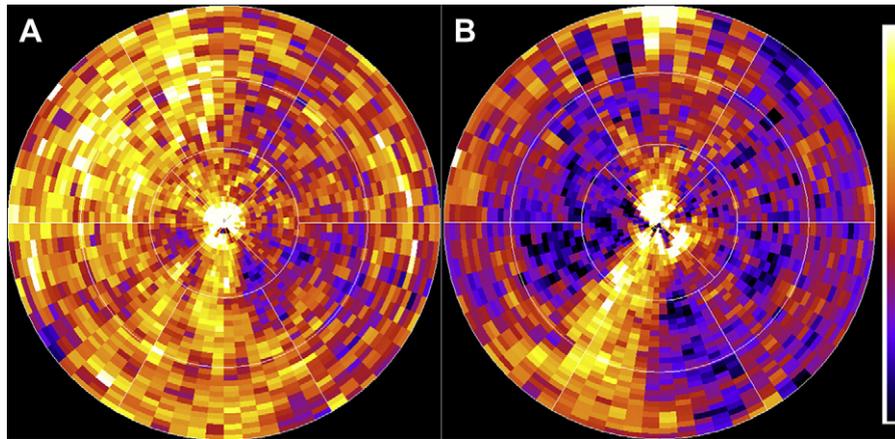
Figure 4 — Detailed bulls-eye plots of the transmyocaridal perfusion ratio of the left ventricle at rest (A) and during adenosine stress (B). Normal areas are shown in yellow/orange, and abnormal areas are highlighted in purple/blue. A color-coded bar on the right shows the range of transmyocardial perfusion ratios from black (0.5) to white (1.5).
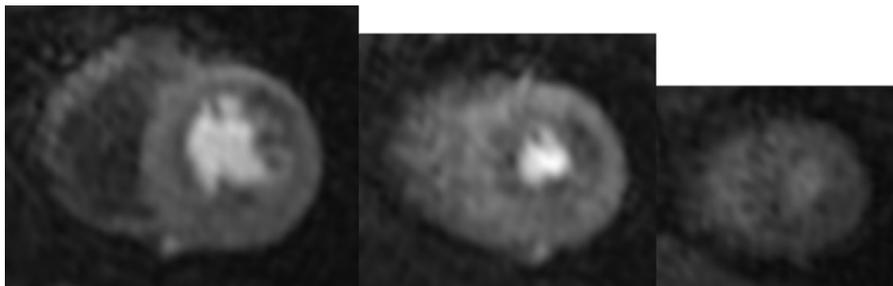

Figure 5 — Magnetic resonance myocardial perfusion imaging during adenosine stress. Short-axis views at 3 points over the left ventricle are shown with perfusion defects that correlate to the computed tomography images.
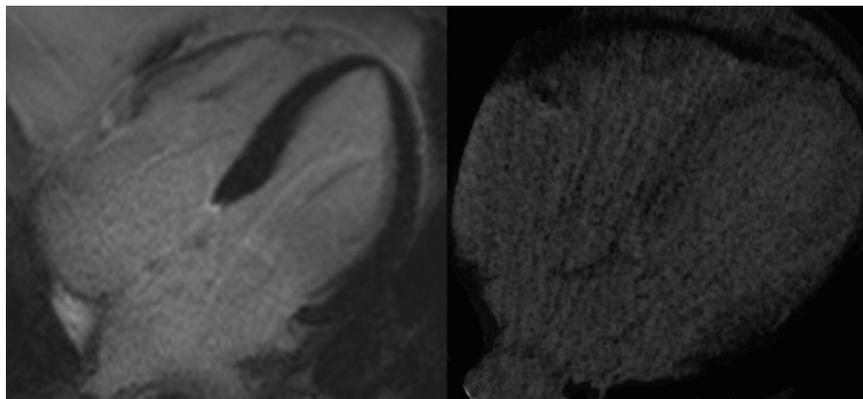

Figure 6 — Delayed enhancement imaging from magnetic resonance imaging on the left and CT on the right. No areas of delayed enhancement were identified.

Video 1). Transmyocardial perfusion ratio plots[2] highlight these defects (Figs. 3 and 4; Supplemental Video 2). Figure 5 shows correlative magnetic resonance perfusion images. Functional assessment identified a mild anteroseptal wall motion abnormality (Supplemental Videos 3–5). Delayed enhancement was not identified on CT or magnetic resonance imaging (Fig. 6). The combined effective radiation dose (k 0.014) for coronary CTA (0.32 mSv), CT perfusion and function (0.79 mSv), and delayed enhancement (0.08 mSv) was 1.19 mSv compared with the coronary calcium scan of 1.05 mSv. The total protocol dose was 2.24 mSv.

Acknowledgments

Supplementary data

Supplementary data related to this article can be found online at http://dx.doi.org/10.1016/j.jcct.2012.11.005.

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