Myocardial defect assessment

Background

Coronary arteries supply blood to the left ventricular muscle (myocardium). Obstructions within the coronary arteries result in significantly reduced blood flow to the relevant territories of the myocardium, thereby causing damage and impairing its function and eventually resulting in myocardial infarction (MI) or death. The affected / infarcted territories are typically seen as hypo-dense regions by cardiac computed tomography angiography (cardiac CTA).[1] In the absence of automatic approaches, the assessment of these hypo-dense regions is user-dependent and requires extensive manipulation, with quantification requiring further examination of multiple adjacent slices, making this time consuming. Hence there is a need to provide robust tools that can help with clinical workflow.

As a leader in cardiovascular imaging, Philips Healthcare continues to innovate in the field of advanced image processing in the field of cardiac imaging. The Philips Myocardial Defect Assessment application on IntelliSpace Portal is one such innovative solution that provides visual and quantitative assessment of hypo-dense regions of the myocardium seen *from a single gated cardiac CTA scan* (retrospectively-gated spiral or Step & Shoot Cardiac). Since this is adjunct information obtained from a single cardiac CTA scan, it does not require any additional scans, thus avoiding any additional increase in radiation dose. Depending on the type of scan performed, the radiation dose could range between 0.6 – 3.5 mSv (if Step & Shoot Cardiac and iterative reconstruction techniques were used) and 8 – 11 mSv (using retrospectively-gated spiral CTA with tube current modulation).[2,3]

The clinical application itself is based on the robust automatic model-based whole-heart segmentation that is developed by Philips Healthcare and implemented in the Comprehensive Cardiac Analysis (CCA).[4,5] By segmenting the coronary arteries, four chambers and the myocardium, this technology becomes a key enabler for improving clinical workflow by helping to address the explosion of data which poses diagnostic challenge to the clinician. A physiologically oriented algorithm is then applied to the segmented myocardium for the visual assessment and quantification of hypo-dense regions.[6] The use of edge-preserving de-noising helps reduce any artifacts within the myocardium.

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sense and simplicity

Once the hypo-dense regions are segmented, both visual and quantitative results are presented to the user. As part of the visual assessment of the low attenuation areas, the clinical application provides several analyses. Myocardial defects probability, Endo-Epi and HU maps are displayed using the following representations:

- A pixel-by-pixel overlay on the short axis images – a local representation that allows examination of the various locations within the myocardium while scrolling through the short axes images. In addition, long axis reference images are displayed along with a reference line representing the current short axis position.
- A polar map (bull's-eye) representation - provides an overview of the entire myocardium. In particular, the defect probability map utilizes the global histogram of the myocardium which allows virtually eliminating the local effect of noise, enabling to clearly distinguish between normal and hypo-enhanced areas.
- A volumetric visualization of coronary arteries along with the selected myocardial defects map displayed as an overlay on top of a 3D myocardial surface

Quantitative information provided includes (1) the volume of areas of decreased attenuation based on the different myocardial defect maps and (2) percentage of the defects out of the total myocardial volume.

The Myocardial Defects Assessment application has shown promising results in the identification and quantification of hypo-dense regions from cardiac CTA scans.[6] The ability to identify hemodynamically relevant coronary stenosis (i.e., anatomical and physiologic data) from a single cardiac CTA scan may facilitate the workflow, and make a significant contribution to patient management without any additional radiation or contrast.[7]

Shown is an example of a 24-year-old male admitted to the emergency department (ED) for chest pain, with ECG demonstrating S-T segment elevation in the inferior wall leads. Since the patient reported recent severe flu-like symptoms, the initial diagnosis was myocarditis. Due to his risk factors (smoking and family history of coronary artery disease (CAD)) cardiac CTA was performed on the Philips Brilliance 64 multi-detector CT (MDCT) to rule out CAD. Initial interpretation suggested the presence of a two-vessel disease: there was plaque in the proximal left anterior descending (LAD) (curved multi-planar reformation shown in Figure 1a) and also the mid-portion of the right coronary artery (RCA) (curved multi-planar reformation shown in Figure 1b).

Myocardial Defects Assessment was performed (overview of the results is shown in figure 2). While no hypo-dense regions were observed in the myocardial territories of the LAD, they were present in the basal- and mid-inferior regions of the myocardium (RCA-PLB territories). This is exhibited in the short-axis representation (Figure 3), with the original grayscale images shown on the left, and the corresponding defect probability color representation shown on the right – the gradient of the color maps represent a range of the myocardial regions that are normal (red) to the hypodense regions (blue).

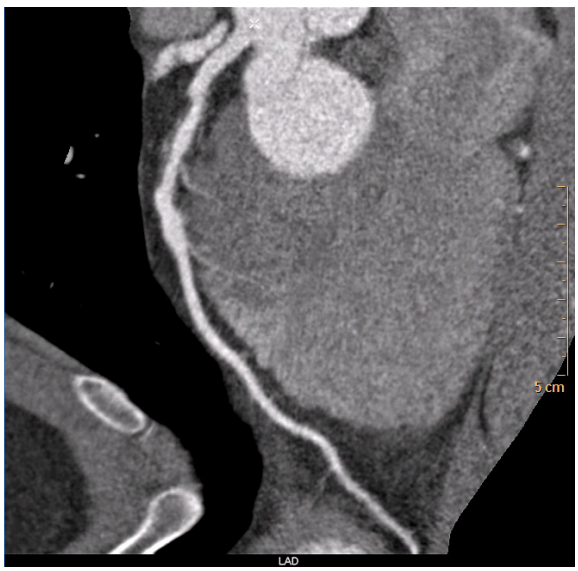

Figure 1(a)

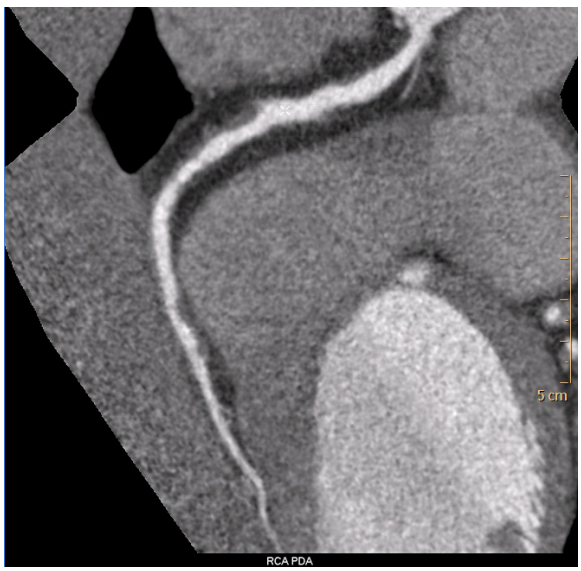

Figure 1(b)

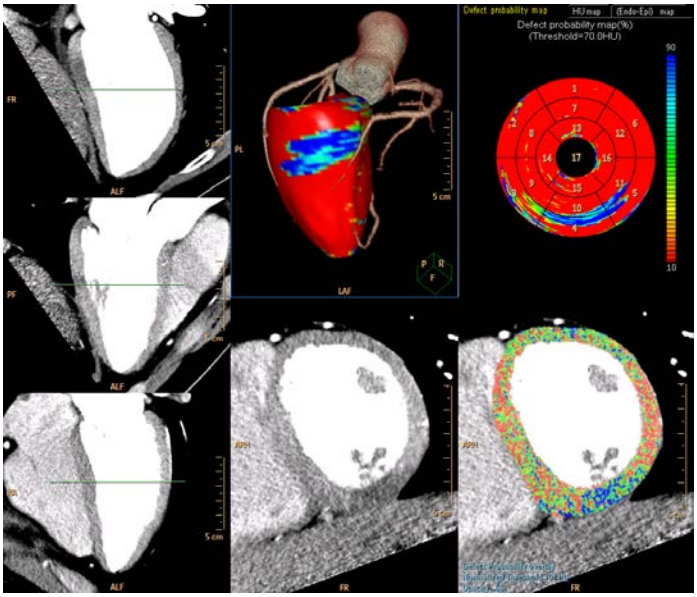

Figure 2

Images courtesy of Dr. Arik Wolak, Head of Cardiac Imaging and Dr. Ilan Shelef, Director of Diagnostic Imaging Institute, Soroka University Medical Center, Beer-Sheva, Israel.

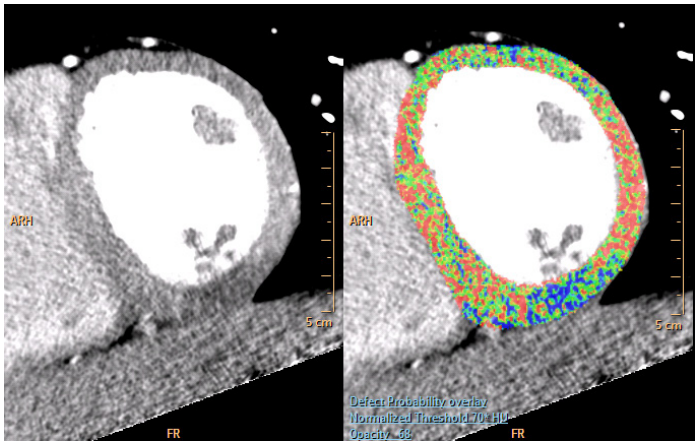

Figure 3

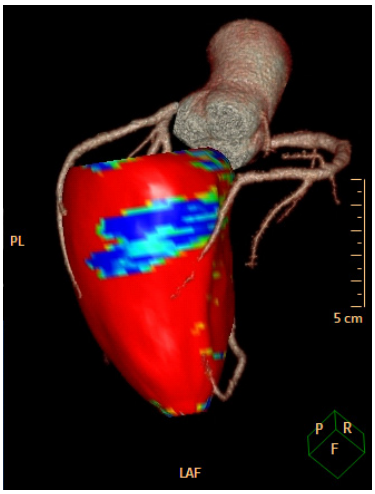

Figure 4(a)

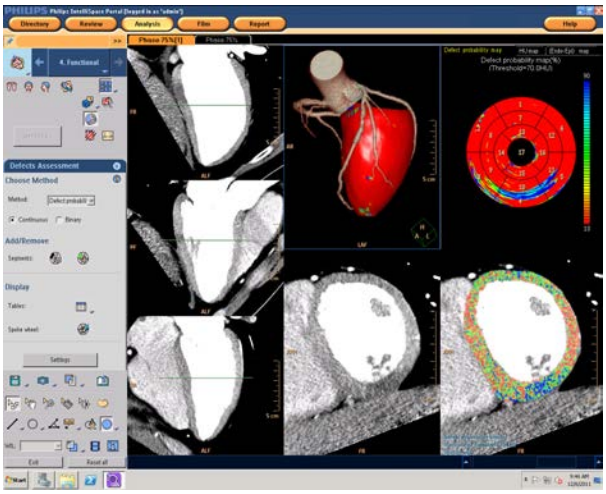

Figure 4(b)

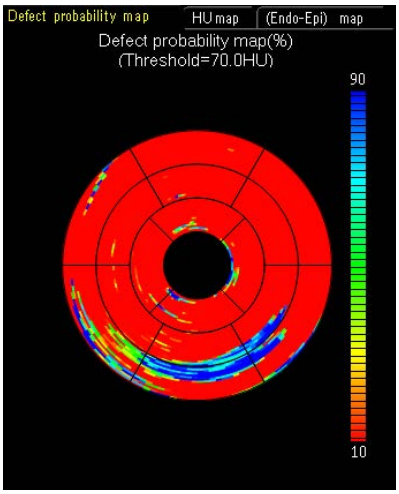

Figure 4(c)

Lastly Figures 4(a) and 4(b), rotated to show the RCA-PLB territories and LAD territories respectively, display the coronary artery tree superimposed on the "egg-shell" color map representation of the LV with blue indicating hypodense regions. Figure 4(c) shows the polar maps representing the short-axis segmentation of LV with the color map overlay using the defect probability method. Due to the perfusion finding, a meticulous second look at the PLB territory was performed and a thrombus at the PLB was found. The patient underwent invasive coronary angiography with the lesion area in the mid-RCA stented. Figure 5 shows the focal lesion in the PLB from the invasive coronary angiography.

Philips is a leader in cardiovascular care and the Myocardial Defect Assessment application is evidence that Philips CT continues to push our leadership position.

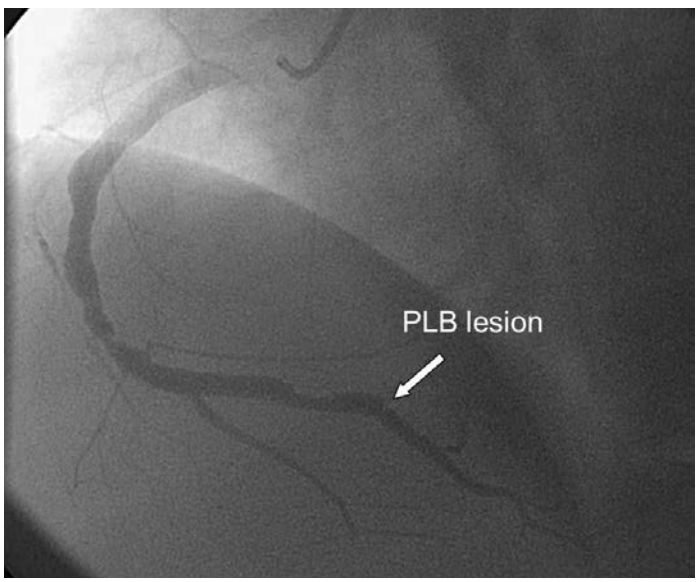

Figure 5

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References:

1. Lessick J, Ghersin E, Dragu R, et al. Diagnostic accuracy of myocardial hypoenhancement on multidetector computed tomography in identifying myocardial infarction in patients admitted with acute chest pain syndrome. *J Comput Assist Tomogr*. 2007 Sep-Oct; 31(5):780-8.
2. Hou Y, Yue Y, Guo W, et al. Prospectively versus retrospectively ECG-gated 256-slice coronary CT angiography: image quality and radiation dose over expanded heart rates. *Int J Cardiovasc Imaging*. 2010 Dec 14. [Epub ahead of print]
3. Hosch W, Stiller W, Mueller D, et al. Reduction of radiation exposure and improvement of image quality with BMI-adapted prospective cardiac computed tomography and iterative reconstruction. *Eur J Radiol*. 2011 Jul 22. [Epub ahead of print]
4. Ecabert O, J and Weese J, "Modeling shape variability for full heart segmentation in cardiac computed tomography images," *Proceedings SPIE Medical Imaging 2006* (Reinhardt JM, Pluim JPW Eds) 6144: 61 443R – 1- 61 443R – 12.
5. Ecabert O, Peters J, Schramm H, Lorenz C, von Berg J, Walker MJ, Vembar M, Olszewski ME, Subramanyan K and Lavi G, "Automatic model-based segmentation of the heart in CT images," IEEE Trans. *Med. Imaging, vol. 27*, 1189 - 1201, 2008.
6. Lamash Y, Lessick J and Gringauz A, "An automatic method for the identification and quantification of myocardial perfusion defects or infarction from cardiac CT images," *IEEE International Symposium on Biomedical Imaging: From Nano to Macro. 2011*. 1314 – 1317. DOI: 10.1109/ISBI.2011.5872642.
7. Kachenoura N, Veronesi F, Lodato JA, et al. Volumetric quantification of myocardial perfusion using analysis of multi-detector computed tomography 3D datasets: comparison with nuclear perfusion imaging. *Eur Radiol*. 2010 Feb; 20(2):337-47. Epub 2009 Aug 27.

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