High resolution CT with Revolution HD for the characterization of coronary plaque ulceration

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Summary

We describe a case of a coronary plaque ulceration on the proximal left anterior descending artery, accompanied by an intimal flap. The exceptional visualization of the small anatomical features of the coronary atherosclerosis that was achieved by using HD technology, allowed for the timely diagnosis of a potentially lethal disease. ischemia and demonstrate its value to this challenging diagnosis.

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Fonte Imagem is an outpatient imaging clinic located in Rio de Janeiro, AAA service, equipped with GE Imaging Technology (MR SIGNA™ Explorer 1.5T, CT Revolution HD, GSi w/ Dual Energy, Nuclear Medicine CZT, Vivid E9, Voluson S8).

Case report

Introduction

Cardiovascular disease is the major cause of mortality in the world, accounting for approximately 1/3 of all deaths in the developed countries [AHA]. Approximately half of the patients that have a myocardial infarction or die from coronary artery disease (CAD) were previously asymptomatic [Circulation paper], underlying the need for earlier diagnosis.

Invasive coronary catheterization is the gold standard method for the diagnosis of obstructive CAD, but due to its invasive nature, is associated with a non negligible risk of complications and higher costs [AHA guidelines]. Coronary computed tomography angiography (CCTA) is a non-invasive imaging modality that has been shown to have higher accuracy rates than other non-invasive imaging modalities [Core64 and meta-analysis]. In fact, the higher sensitivity as well as higher specificity as compared to other modalities, has rendered CCTA as the first line imaging modality in the investigation of suspected obstructive CAD [NICE Guidelines].

The Gemstone detectors have favourable physical characteristics for the acquisition of high resolution angiography, allowing for very high sampling rates on any one rotation (known as “views”). HD technology provides an increase in the number of views per rotation from 984 to 2496 for non-cardiac and from 655 to 1662 for half scan in cardiac mode, resulting in higher inplane resolution. Many different technical advances allowed for the HD to perform likewise, but the two of the most important were the detectors’ scintillation high washout rate, resulting in low afterglow; and very high sensitivity detectors, allowing for good signal to noise ratios needed with high sampling rates.

The purpose of this White Paper is to describe a case where high resolution CCTA images were fundamental in the diagnosis of a lethal presentation of unstable CAD, i.e. plaque ulceration resulting in endothelial flap in the proximal left anterior descending artery.

Patient History

A 87 year old male (87 kg and 1,78 cm) with prior history of CAD (coronary stent placed 8 years prior) was referred for CCTA (Revolution HD, GE Healthcare, Milwaukee, USA) with symptoms of chest pain for the last 3 weeks, associated with increased efforts such as climbing stairs and walking uphill.

Acquisition protocol

Image acquisition was done before and during the administration of venous contrast medium, which were post-processed, obtaining axial and multiplanar and three-dimensional reconstructions. Effective Radiation dose of this CCTA was 3.5 mSv. Iodinated contrast volume was 70 ml and sublingual nitroglycerin, as well as intravenous beta-blockers were used.

The acquisition protocol is summarized in Table 1

Acquisition Protocol	Revolution HD
Tube voltage [kV]	120
Tube current [mAs/rot]	740
Acquisition mode	Axial prospective gating
HD Mode	On
Padding [ms]	80
Scan length [mm]	104.37
Scan direction	Cranio caudal
Rotation Time [s]	0.35
Scan time [s]	6
Slice collimation [mm]	0.625
Recon Increment	0.6
Slice width [mm]	0.625
Heart rate [bpm]	44-50
Recon kernel	HD Soft and HD Standard
Contrast [mg/mL]	370
Contrast volume [ml]	70
Flow rate [mL/s]	6.0
Start delay	Visual / Manual
DLP	248.9
CTDIvol	23.7
mSv	3.5

Table 1. Effective radiation dose 3.5 mSv

CT findings

The coronary system was right dominant.

Left main coronary had minimal luminal irregularities.

Left Anterior Descending (LAD) crossed the apex cordis, had a partially calcified plaque on the proximal segment that appeared ulcerated and contained an intimal flap. The plaque per se determined mild stenosis (approximately 30-40%) but the flap appeared to obstruct approximately 70% of the lumen. A stent was well visualized at mid LAD and had no signs of restenosis. The diagonal branches had mild obstructions.

Left Circumflex Artery (LCx) had moderate anatomical importance, and showed foci of mild stenosis, the same with the left marginal arteries.

Right Coronary Artery (RCA) was dominant, and also showed sparse foci of mildly obstructive CAD.

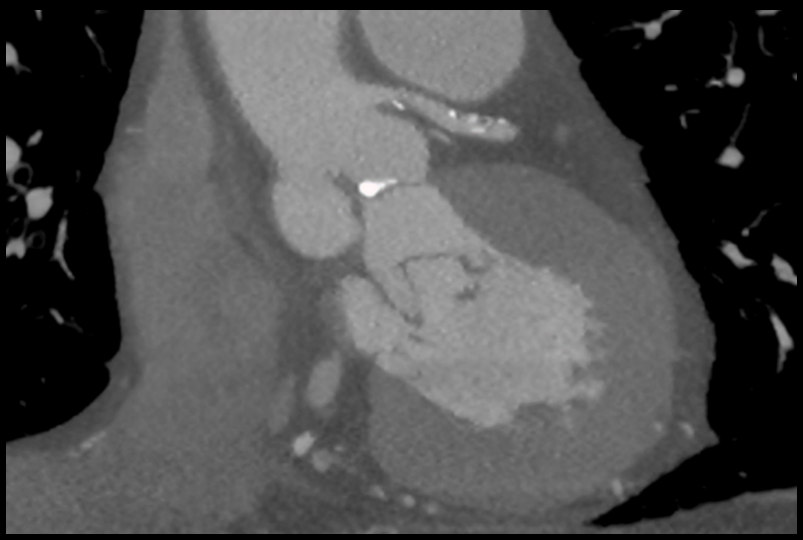

Figure 1. MPR demonstrating the proximal LAD segment with an ulcerated plaque

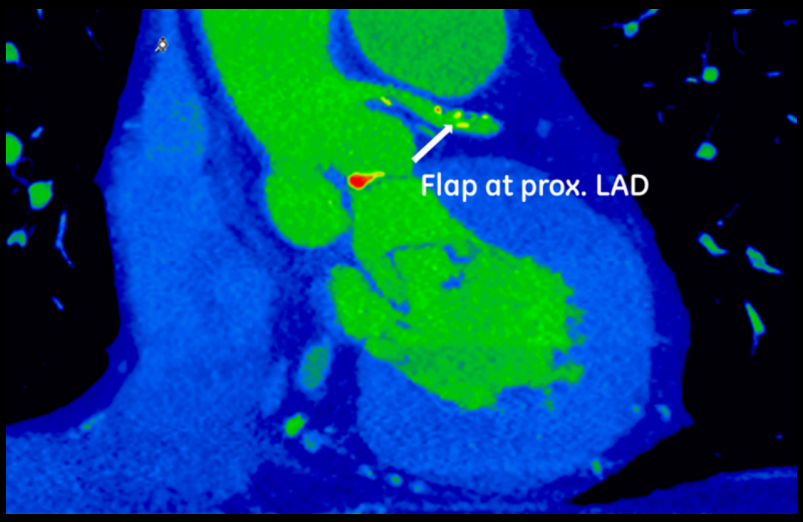

Figure 2. Depiction of the proximal LAD ulcerated plaque in colours for better visualization of the intimal flap (white arrow)

Figure 3. Volumetric reconstruction of the coronary tree.

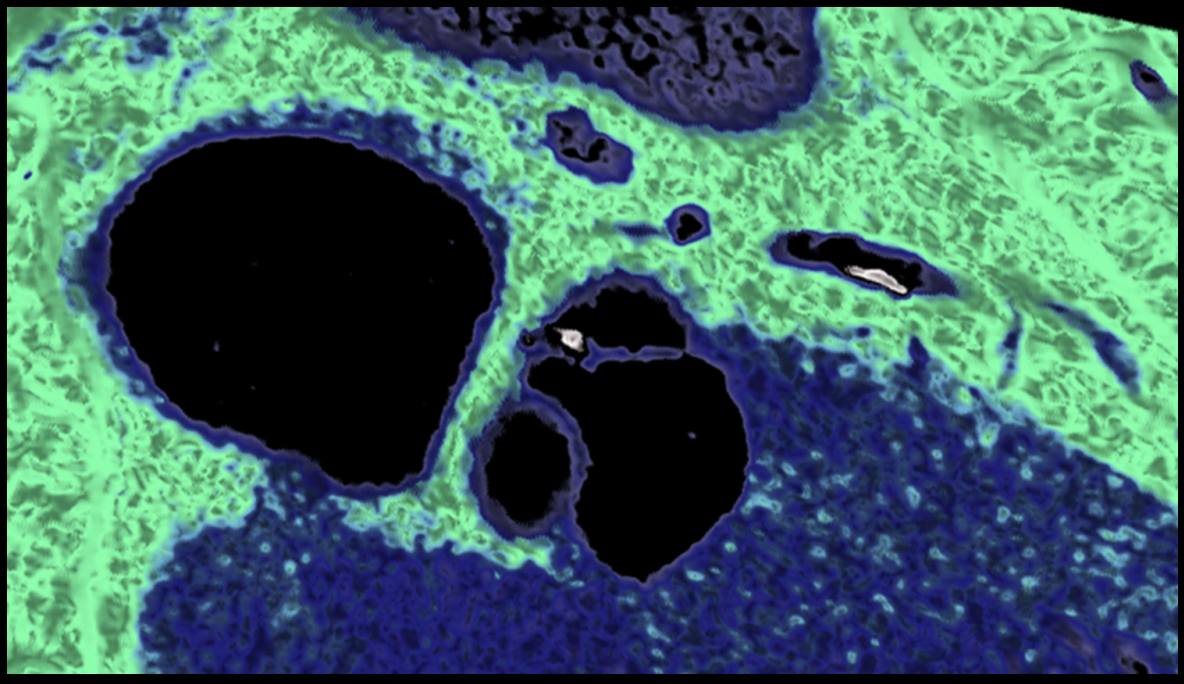

Figure 4. IVUS reconstruction showing the intimal flap.

Clinical summary

CCTA highlights ulcerated plaque at proximal LAD with intimal flap likely significantly obstructing the coronary lumen. A stent at mid LAD is free of significant restenosis.

The patient underwent invasive coronary catheterization and intravascular ultrasound that confirmed the CCTA findings. A new stent was successfully and uneventfully placed on the proximal LAD and the patient followed up asymptomatically one month after the procedure.

Keypoints

- HD mode enables high inplane resolution imaging by using increased sampling rate. The HD technology is important for the characterization of coronary plaque morphology, and was crucial for the visualization of plaque ulceration, which would be very difficult in conventional CT.

- Reconstruction Algorithms like HD Soft and HD Standard additionally increase spatial resolution.

About the Author

Post-Doctoral Fellowship from Johns Hopkins University. PhD in Radiology and Masters in Cardiology from the Federal University of Rio de Janeiro. Dr Gottlieb has over 40 internationally published studies on the field of cardiac imaging.

References:

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