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Leading Innovation >>>

Coronary CTA and Arrhythmia Overcoming the Unexpected

ONE
Aquilion
dynamic volume CT

Case Study Brochure
Hong Kong Sanatorium & Hospital



TOSHIBA MEDICAL SYSTEMS CORPORATION

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ONE
Aquilion

Coronary CTA and Arrhythmia

Overcoming the Unexpected

Introduction

Hong Kong Sanatorium & Hospital is an internationally accredited private hospital and one of the most prestigious in Hong Kong. The hospital was opened in 1922 and has grown into a 500 bed facility providing a wide range of specialty services to the community.

The radiology department is unique in having high-end CT systems from three major manufacturers installed side by side. The Aquilion ONE™ was installed in July 2008, and since then, the majority of cardiac CT examinations have been performed on this system. Over 5500 cardiac examinations have been performed since the scanner was installed, with close to a 100% success rate.

The robust arrhythmia rejection software allows us to perform cardiac CTA on all patients with confidence that the scan will result in diagnostic images every time without the necessity of repeat scanning. This ensures the lowest dose and contrast volume for the patient.

In January 2010, we began performing myocardial perfusion* examinations on the Aquilion ONE. The robust arrhythmia rejection software enables us to perform scans under pharmacological stress with confidence that every scan will be diagnostic.

In many patients with arrhythmia, the actual symptoms were due not to coronary artery disease but to the effects of the arrhythmia. This brochure includes a selection of cases in which the patient experienced arrhythmia during the scan.

*Not available in the US

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WARNING: Any reference to x-ray exposure, intravenous contrast dosage, and other medication is intended as a reference guideline only. The guidelines in this document do not substitute for the judgment of a healthcare provider. Each scan requires medical judgment by the healthcare provider about exposing the patient to ionizing radiation. Use the As Low As Reasonably Achievable radiation dose principle to balance factors such as the patient's condition, size and age; region to be imaged; and diagnostic task.

Arrhythmia Rejection

The Aquilion ONE, with its ability to capture the entire heart in single-shot volumetric scan mode, provides unique capabilities for imaging the heart with CT. Unlike helical scan techniques, no table movement is required in volume scan with the Aquilion ONE, providing cardiac images that are temporally uniform along the z-axis and eliminating the possibility of misregistration. As a result, volumetric scan mode permits scanning to be performed during a small portion of the cardiac cycle in as little as one gantry rotation, dramatically reducing the exposure dose.

To capture the entire heart in one rotation at end diastole, for example, requires careful monitoring of the patient's heart rate, but this can be challenging in patients with unstable heart rates. To ensure accurate timing of the exposure window, Toshiba has developed Realtime Beat Control (RBC) software, which monitors the patient's heart rate from the time the patient is registered in the scanner. Essentially, the algorithm formulates a heart rate trend for each patient that is updated with each heartbeat right up to the time of the scan. In this way, the width of the exposure window is tailored exactly to every patient, ensuring that a diagnostic examination is achieved in all patients. The exposure window is smallest for patients with slow and steady heart rates and slightly larger for patients with unstable heart rates.



Regular Heart Rate: ONE Rotation Volume Scan



Irregular Heart Rate

When a patient is in the scanner and receiving contrast medium injection for a cardiac CTA examination, then the goal of achieving a diagnostic examination is clear, no matter what the cardiac rhythm. This includes patients with cardiac arrhythmias and patients who experience an anomalous heartbeat during the scan. The Realtime Beat Control software incorporates a sophisticated arrhythmia detection algorithm that automatically adjusts the exposure in real time in response to the patient's heart rate.

The arrhythmia detection software will reject an abnormal heartbeat and minimize exposure, with the primary aim to acquire high-quality diagnostic images. In the example below, a single unexpected short heartbeat occurs during the scan. In this case, the system immediately terminates the exposure and acquires the scan in the next normal heartbeat.



Anomalous Heartbeat

There are a wide variety of cardiac arrhythmias that would make it impossible to acquire a diagnostic scan in helical mode. For this reason, the arrhythmia detection software in the Aquilion ONE has been trained to recognize arrhythmic beats and adjust the exposure timing in response to abnormal cardiac rhythms.

In the example below, the patient experiences a premature ventricular contraction (PVC) during the scan. A PVC is characterized by a very short heartbeat and is followed by a compensatory long heartbeat. The software recognizes this pattern and aborts the exposure in the abnormal beat. In order to ensure that a motion-free diagnostic scan is obtained in the next beat, the exposure window is extended to include the next R wave to make certain that the diastolic phase is captured. As a result, the examination is diagnostic, and a failed examination with wasted X-ray exposure is avoided.



Arrhythmic Beat: Premature Ventricular Contraction

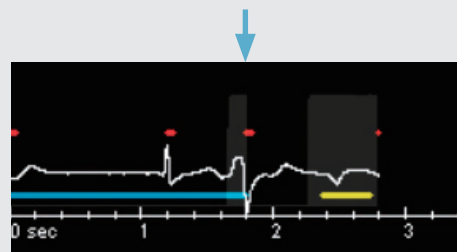
Only two straightforward examples have been described here, but the arrhythmia detection software will react to a wide variety of arrhythmic beats as soon as they occur. The innovative RBC software is standard in every Aquilion ONE system and will work to ensure that every patient receives the best possible cardiac CT examination even if the unexpected occurs.

Ventricular Ectopy

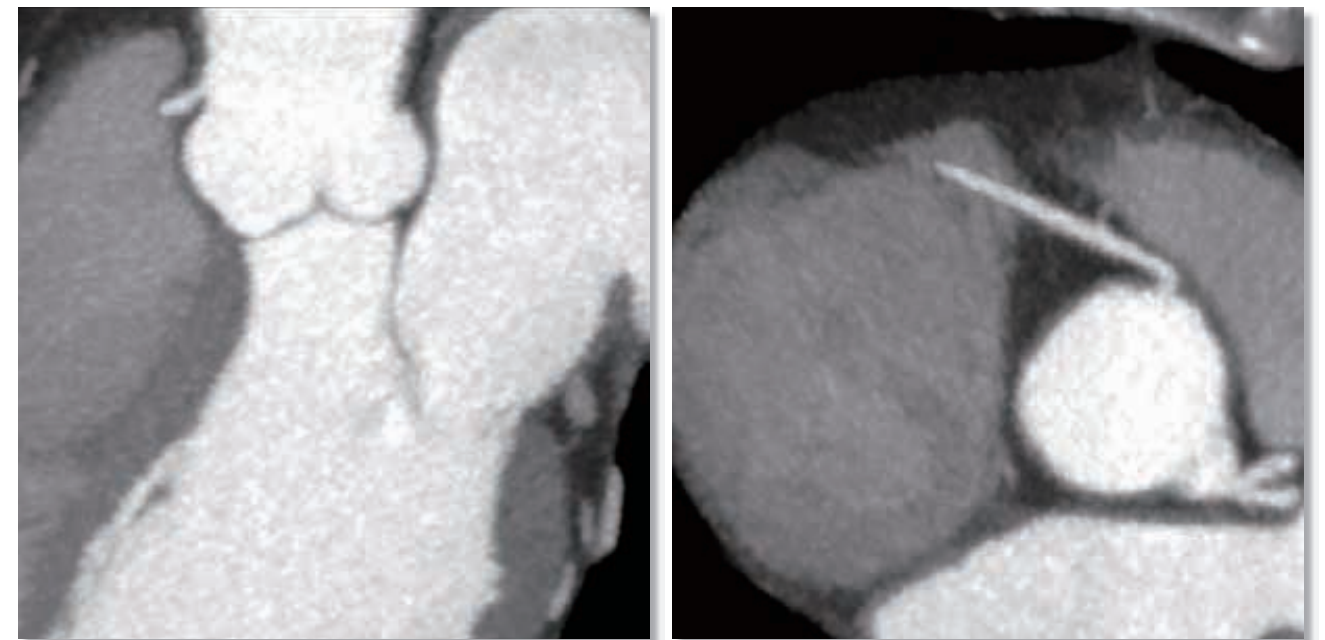
Heart rate during scan = 59-80 bpm

Introduction

This 61-year-old woman with recurrent ventricular ectopy presented with a chief complaint of chest tightness.



During the scan, the patient experienced a ventricular ectopy (arrow). The exposure was immediately terminated and the scan was acquired in the next normal heartbeat.



These MPR images demonstrate the origin of the RCA. The left main coronary artery arises normally from the left coronary cusp.

Findings



The right coronary artery arises from the ascending aorta just above the right coronary sinus, as shown in these 3D images.

Conclusion

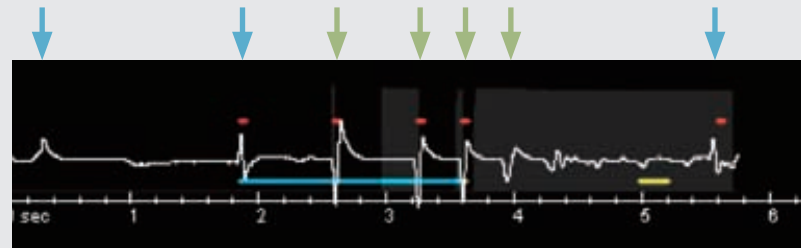
Despite the arrhythmic beat during the scan, diagnostic images could be obtained in this case. An anomalous origin of the right coronary artery above the right coronary cusp was demonstrated in this scan. This anomaly is considered to be benign.

Ectopic Run

Heart rate during scan = 30-170 bpm

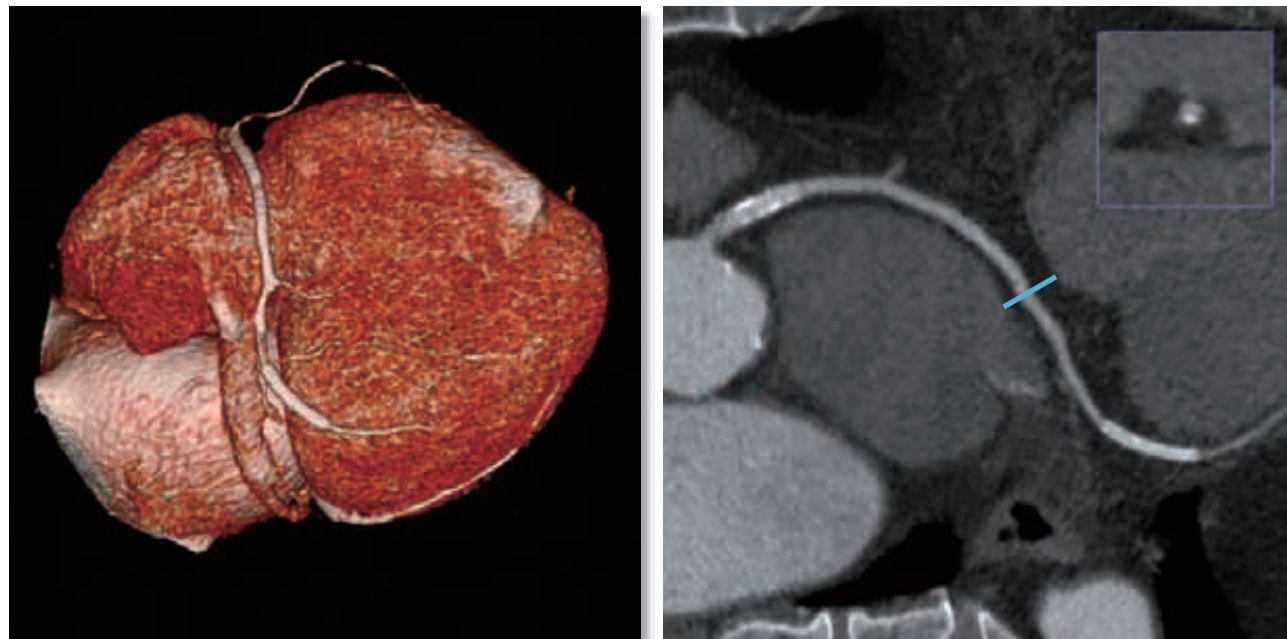
Introduction

This 62-year-old-man had previously undergone stent placement in the RCA and LCx and was taking Warfarin for premature atrial fibrillation. A CT scan was requested to assess the patency of the stents and other coronary vessels.

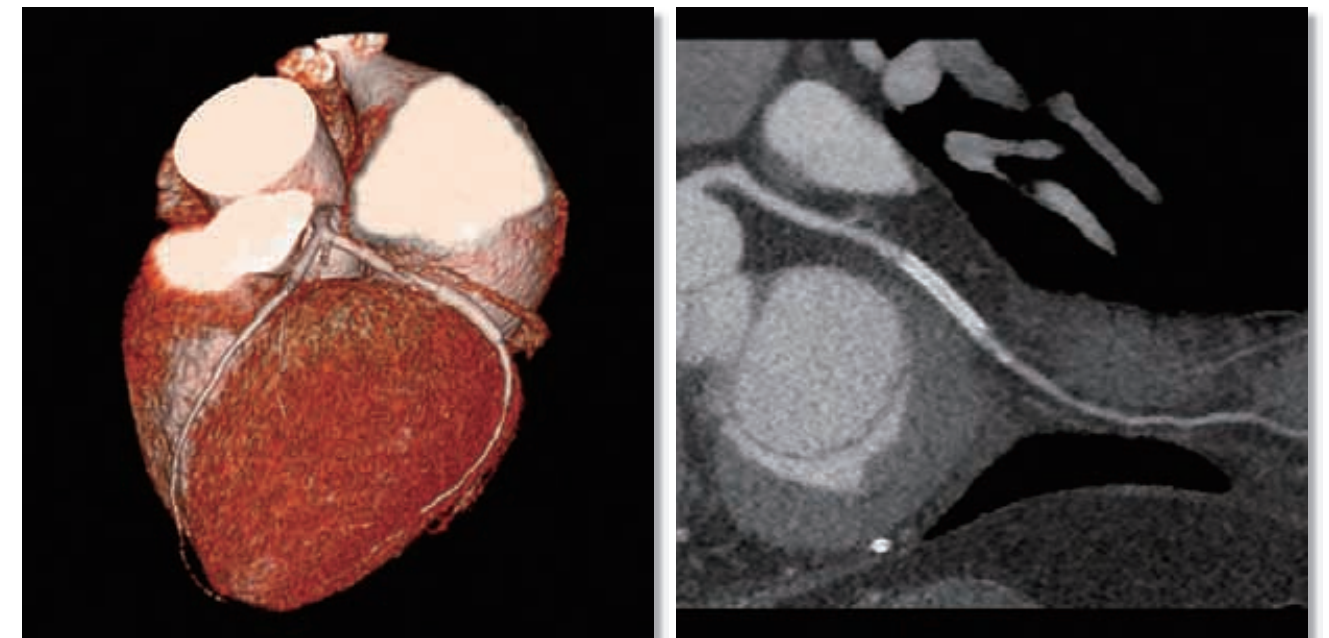


The patient has atrial fibrillation as an underlying cardiac rhythm (blue arrows). During the scan, the patient experienced an ectopic run (green arrows). Several short exposures were aborted before the scanner captured images in a normal heartbeat.

Findings



Two stents have been placed in the RCA. Both stents appear patent. A mixed plaque is seen in the mid RCA. This was considered to be causing less than 50% stenosis.



The stent in the mid LCx is patent, as seen in the curved MPR image. The 3D image shows the LAD to be free of disease.

Conclusion

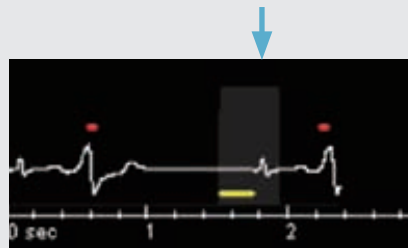
In this patient with an ectopic run of beats, the cardiac rhythm was highly variable, but diagnostic images could be obtained by waiting for the heart rate to stabilize, permitting reconstruction from the diastolic phase of the last beat. Diagnostic images could not have been obtained using helical scan mode in this case because such a high degree of heart rate variation would have resulted in missing data.

Fusion Beat

Heart rate during scan = 36 bpm

Introduction

This 30-year-old woman presented with a history of ventricular premature complexes, mitral regurgitation, pulmonary regurgitation, and atrial fibrillation.



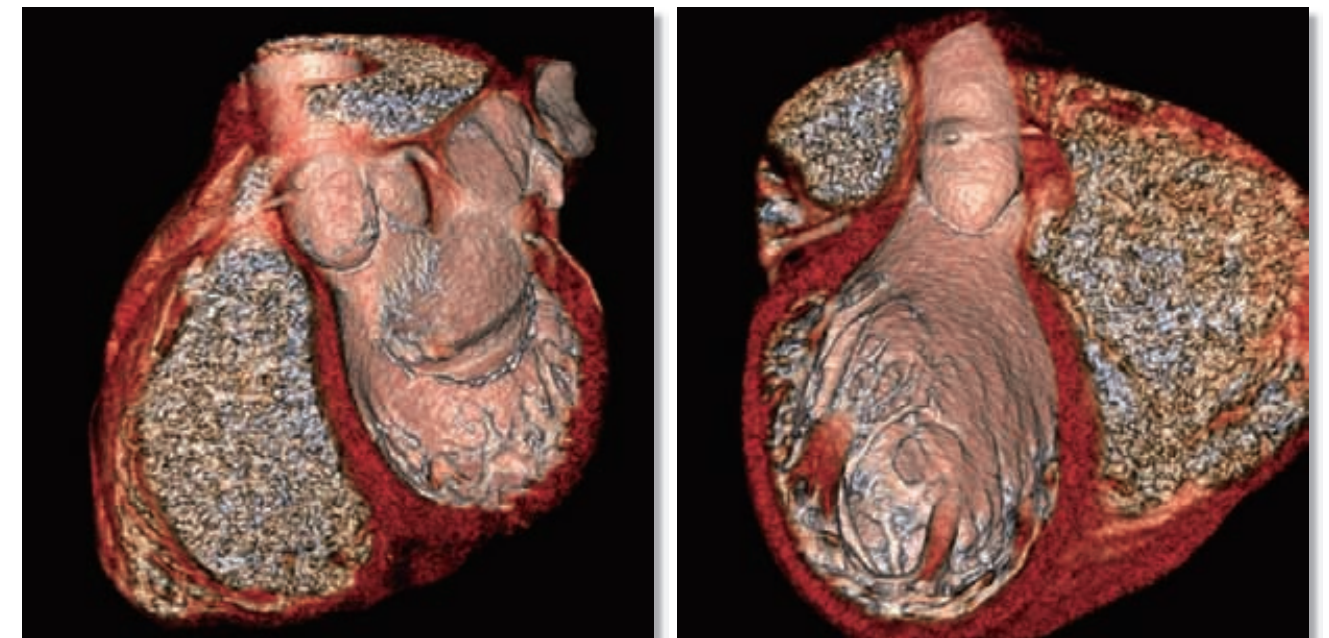
During the scan, the patient experienced a fusion beat (arrow), in which the left atrium and ventricle contract at the same time.

Since a small exposure window of 70% to 80% was planned, it was possible to adjust the reconstruction phase to avoid this abnormal area.

Findings



The RCA arises from the ascending aorta immediately above the right coronary cusp. This anomaly is considered to be benign.



The position of the origin of the right coronary artery is well demonstrated in these cut-away 3D images. The left main coronary artery arises normally from the left coronary cusp.

Conclusion

This scan demonstrates an anomalous origin of the right coronary artery. This anomaly is considered to be benign.

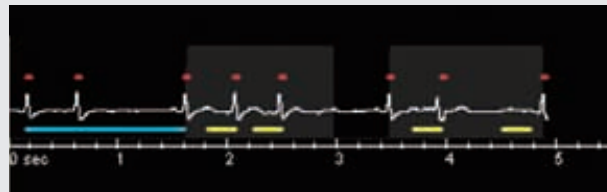
Despite this patient's complex cardiac history of arrhythmia and regurgitation, diagnostic images were obtained with a low exposure dose.

Atrial Fibrillation

Heart rate during scan = 60-145 bpm

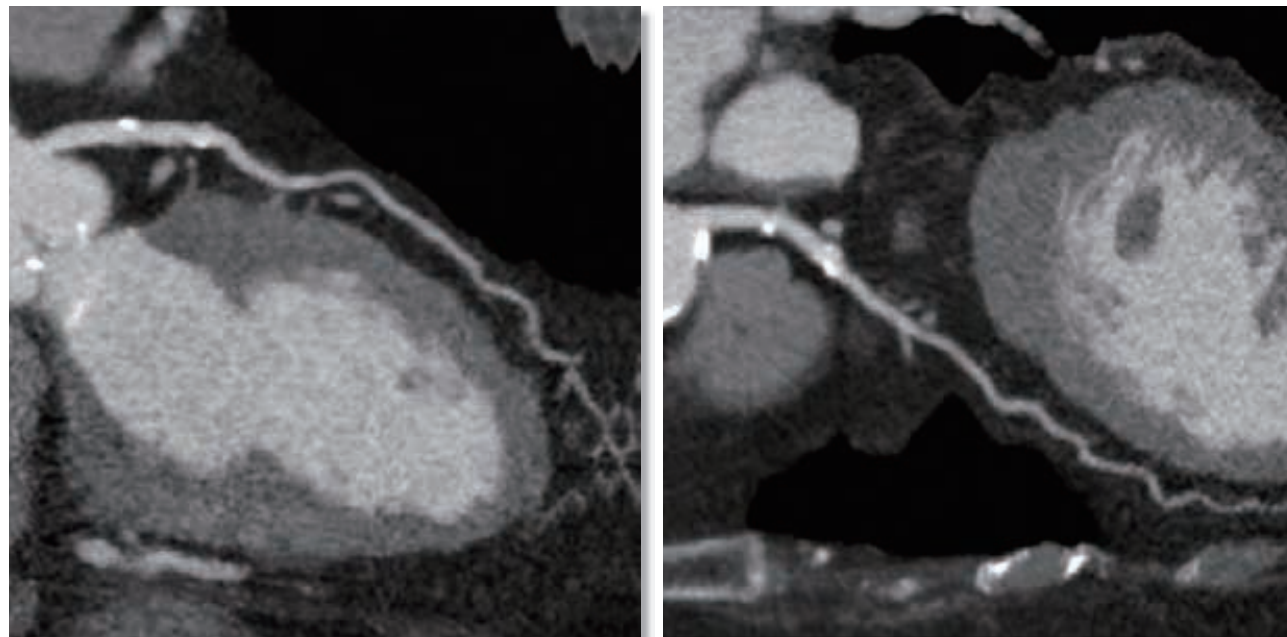
Introduction

This 92-year-old woman presented with hypertension. She had atrial fibrillation on arrival to the CT department.

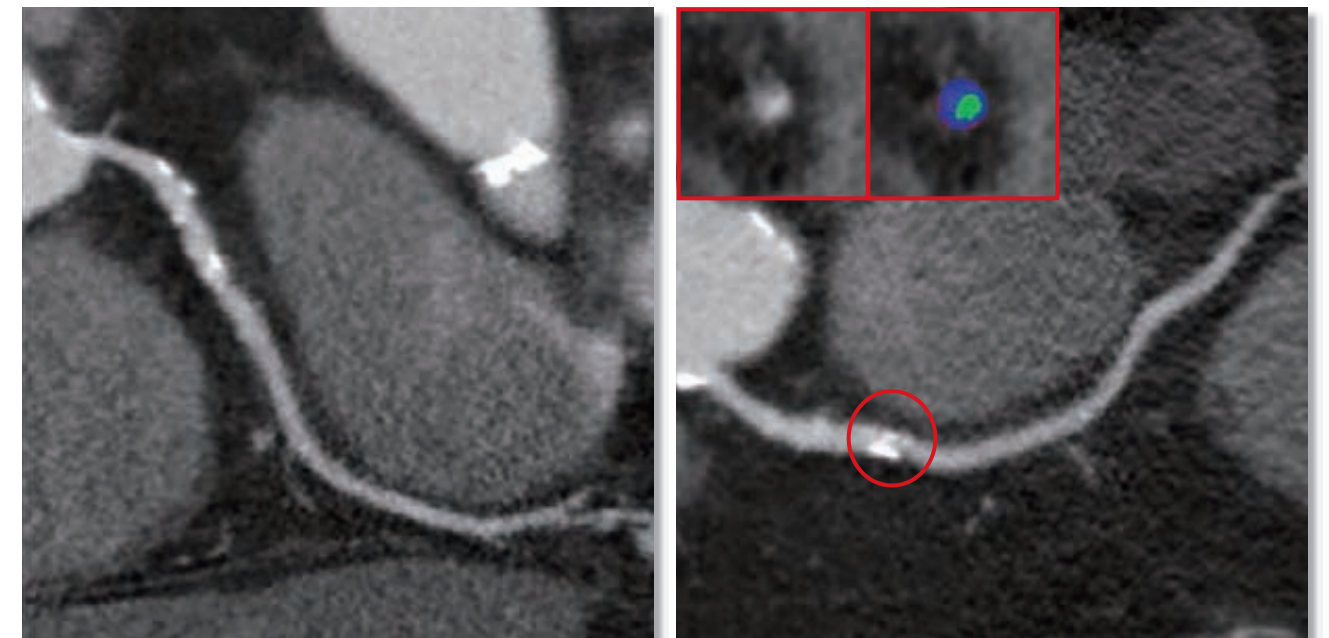


During the scan, the patient's atrial fibrillation continued, characterized by an irregular heart rate.

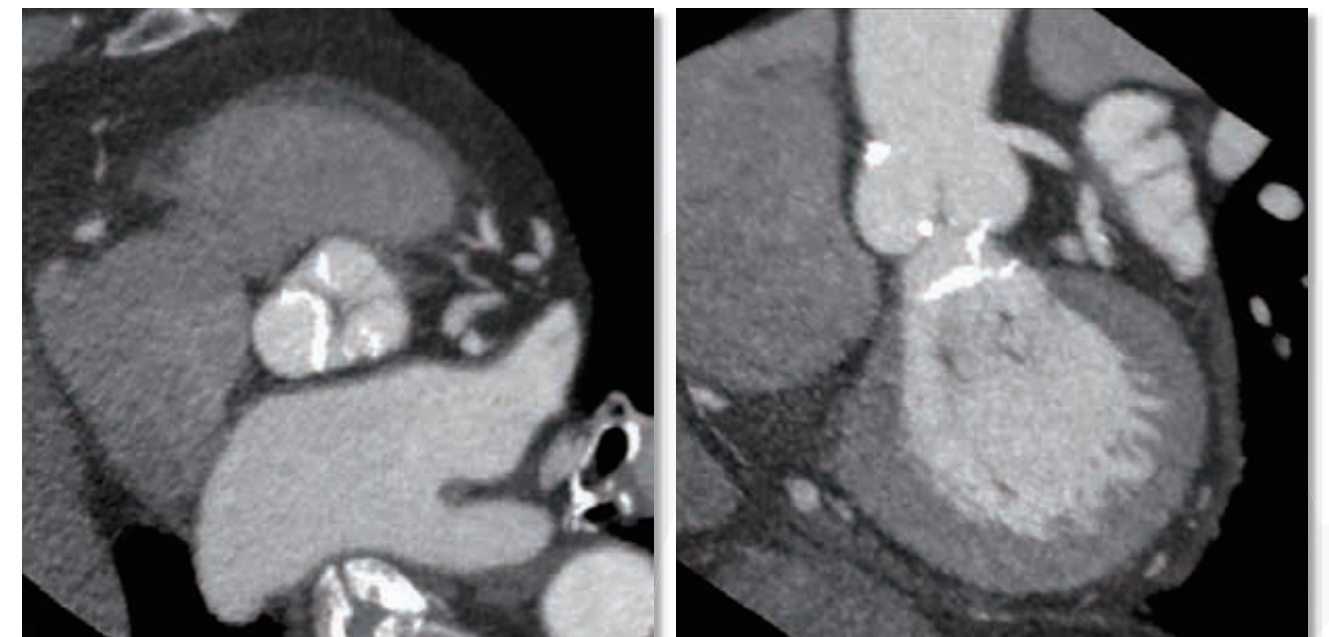
Findings



Calcified plaques are seen in the proximal LAD. These lesions were determined to be causing not more than 50% stenosis. A calcified plaque is also demonstrated at the origin of the left main coronary artery. This lesion is not causing a hemodynamically significant stenosis.



Calcified and noncalcified plaques are demonstrated in the proximal and mid RCA. The noncalcified lesion was determined to be causing approximately 50% stenosis.



Calcification of the leaflets of the aortic valve is seen in these MPR images.

Conclusion

This scan demonstrates stenosis in the RCA and LAD. The lesion in the RCA is considered to be causing approximately 50% stenosis.

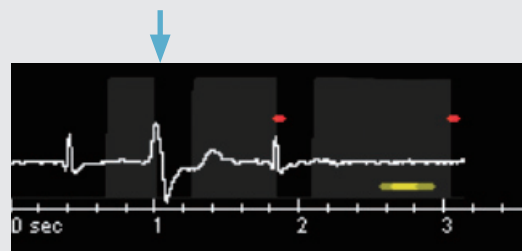
The powerful combination of arrhythmia detection software and multisegment reconstruction provided high-quality diagnostic images in this patient. It is unlikely that any diagnostic information could have been obtained using helical scan mode.

Premature Ventricular Contraction

Heart rate during scan = 50-102 bpm

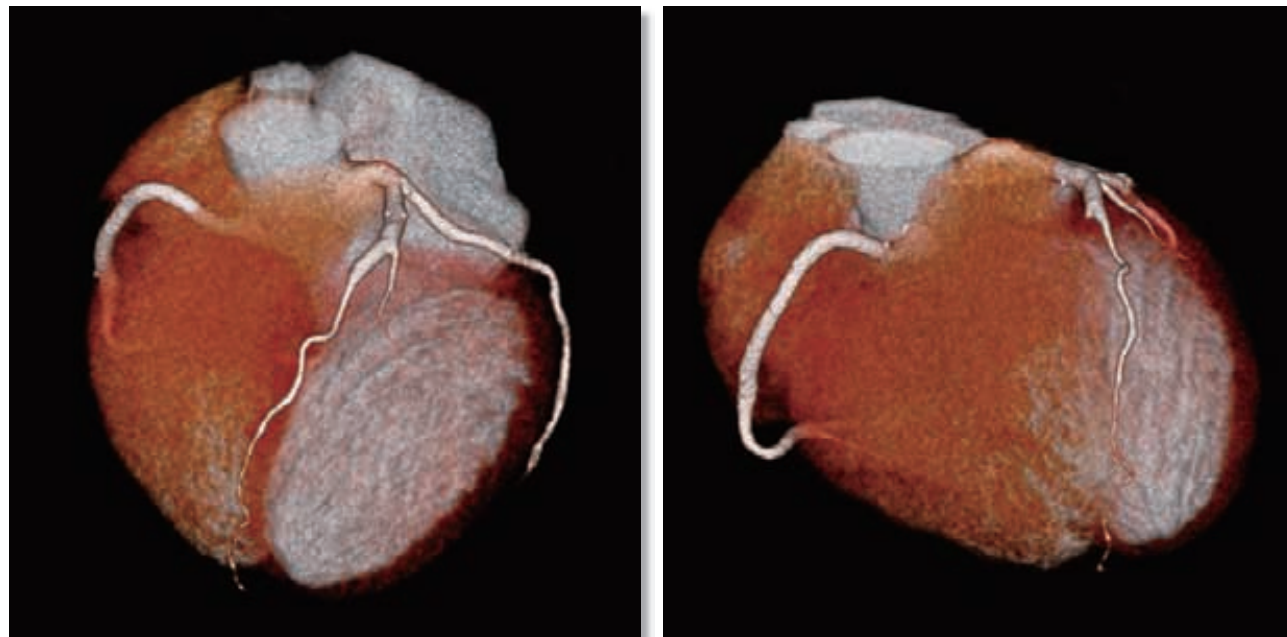
Introduction

This 46-year-old man presented with shortness of breath on exertion. The results of a previous treadmill stress test were abnormal. A CT scan was requested to rule out coronary artery disease. When the patient arrived in the department, premature ventricular contractions (PVCs) were seen on the initial ECG trace. As such the patient was rescheduled to be examined on the Aquilion ONE.

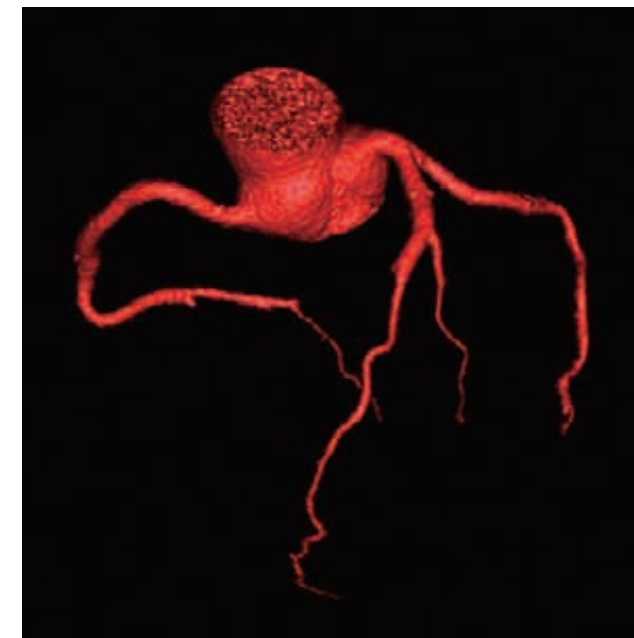


During the scan, the patient experienced a PVC (arrow). The scan was terminated once a normal heartbeat was acquired.

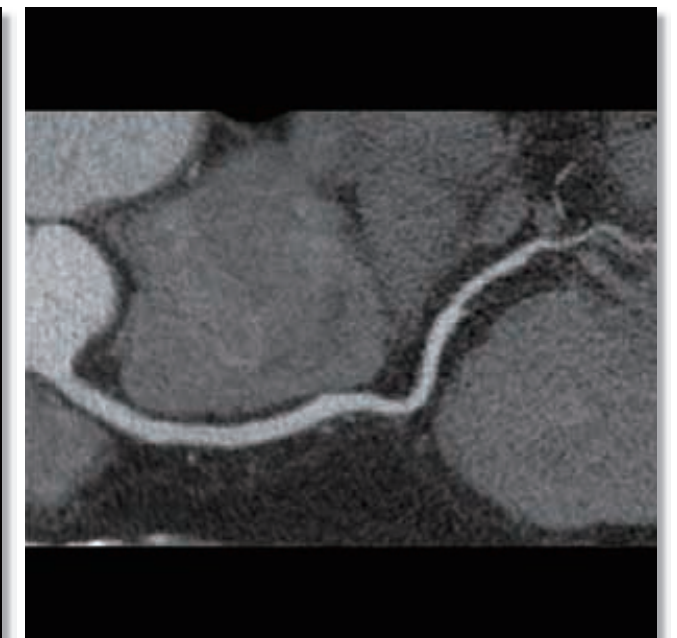
Findings



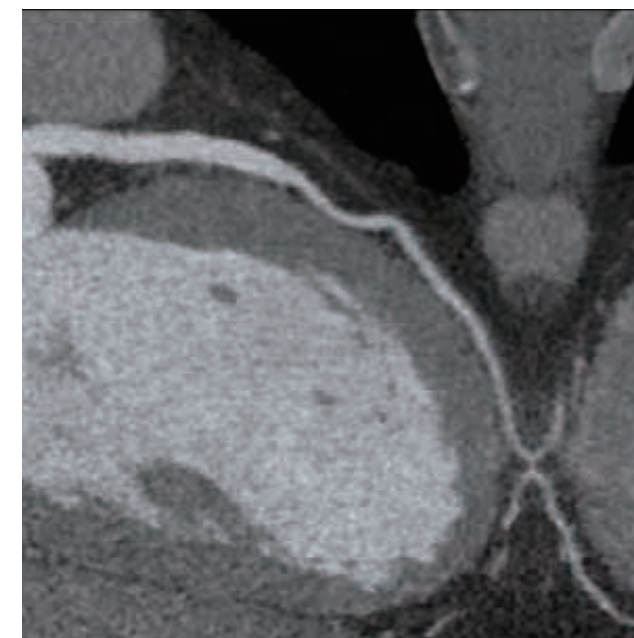
The coronary arteries are normal. The RCA is dominant, supplying the PDA and the base of the heart. There is no evidence of stenosis in the coronary arteries.



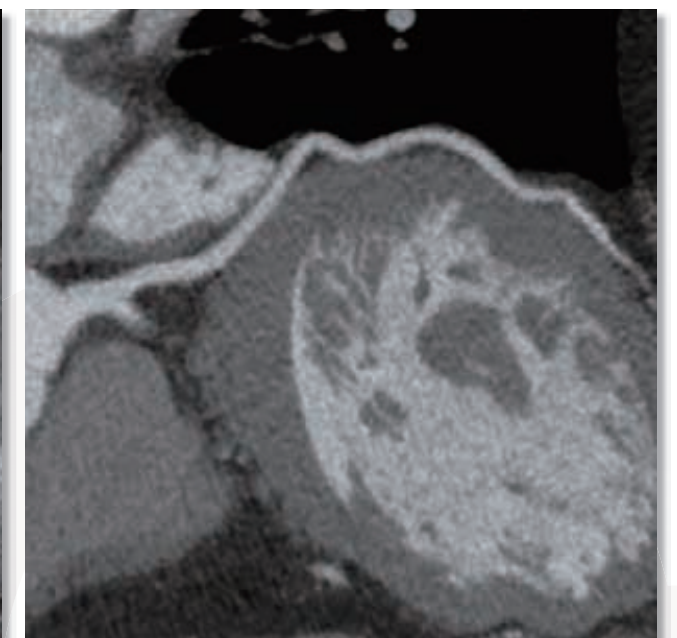
3D



RCA



LAD



LCx

The proximal LAD is ectatic, as seen in the curved MPR images. The mid to distal LAD is of normal caliber. There is no evidence of disease in the right coronary and left circumflex arteries.

Conclusion

The Aquilion ONE guaranteed a high quality diagnostic scan in this patient despite the occurrence of a PVC during the planned acquisition. By scanning this patient with the Aquilion ONE, a repeat examination with additional contrast media was avoided.

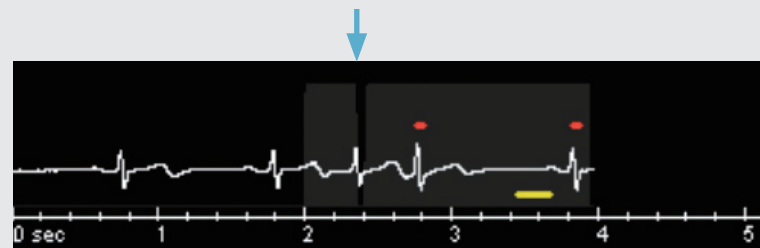
Coronary artery disease was successfully ruled out in this patient.

Premature Junctional Beat

Heart rate during scan = 55-145 bpm

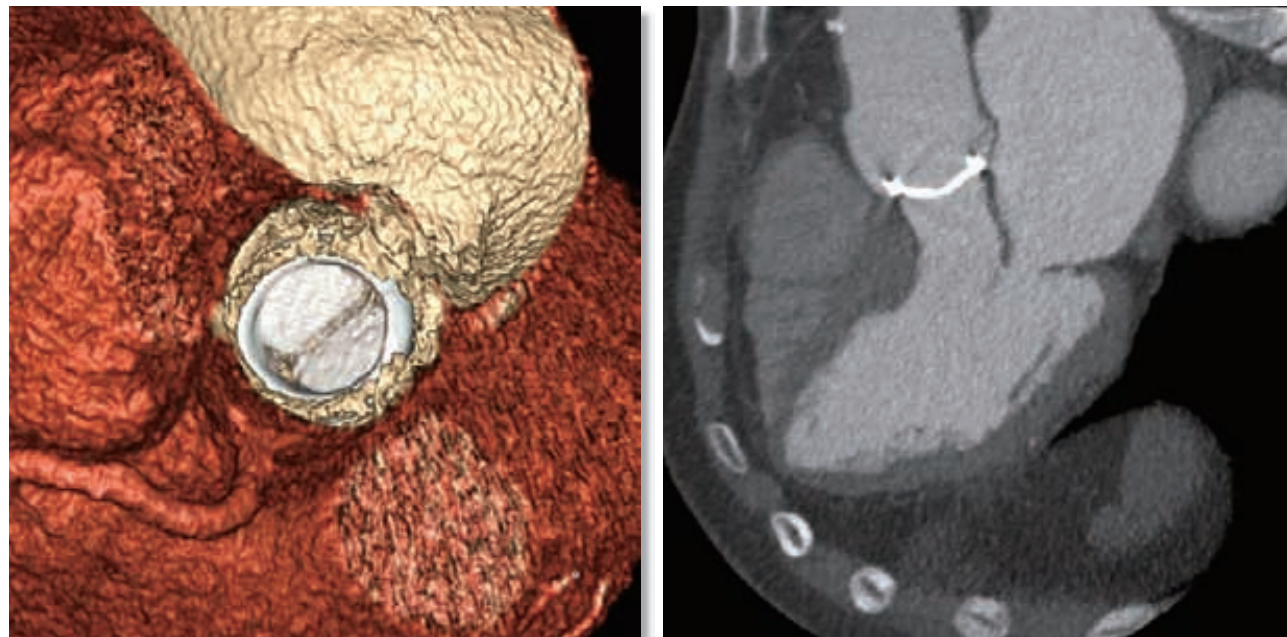
Introduction

This 69-year-old man complained of chest pain and palpitations. Blood tests showed elevated LDL cholesterol. The patient had undergone aortic valve replacement in 1999. When the patient arrived in the department, atrial fibrillation was seen in the initial ECG trace.

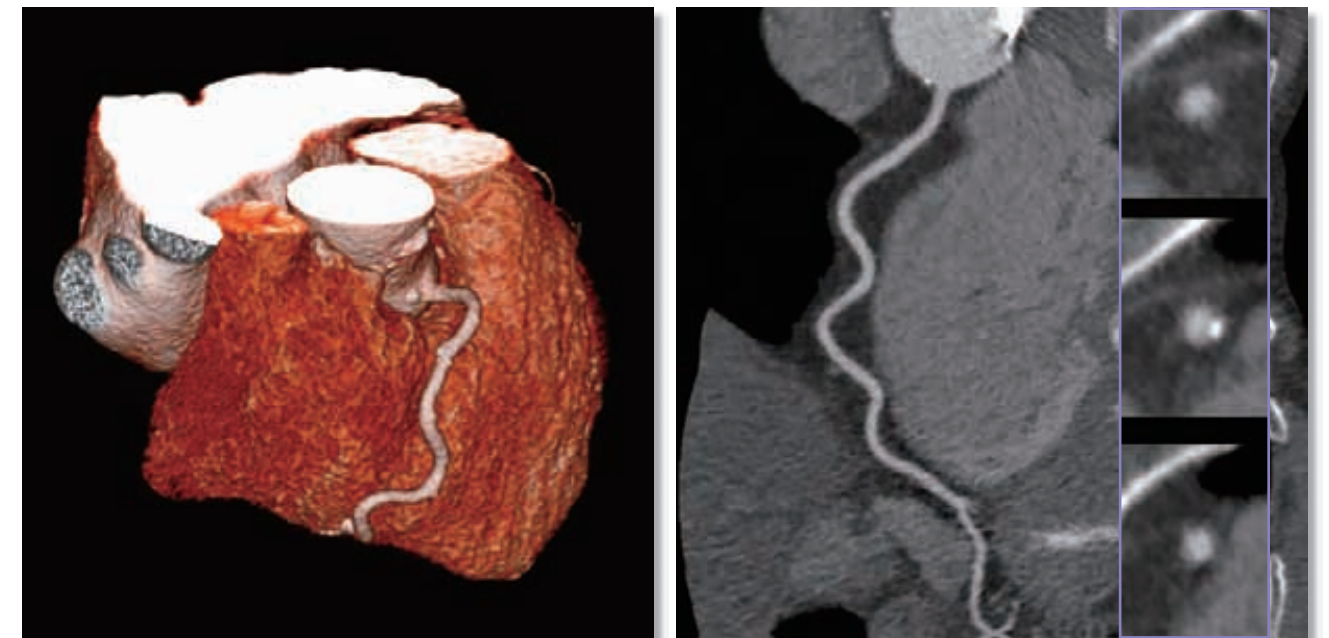


During the scan, the patient experienced a premature junctional beat (arrow). The second beat was used for reconstruction. No atrial fibrillation was seen during the scan.

Findings



The prosthetic aortic valve is seen in these MPR and 3D images. The metallic leaflets are well demonstrated in the 3D image.



A small calcified plaque is seen in the proximal RCA. It was determined that the lesion is causing less than 50% stenosis and is not considered hemodynamically significant.

Conclusion

This patient had previously undergone aortic valve replacement. The metallic valve leaflets are well demonstrated in this scan. The calcified lesion observed in the proximal RCA is not considered hemodynamically significant.

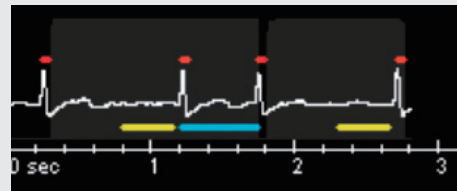
Atrial fibrillation is a common finding in patients undergoing cardiac CT. Only the Aquilion ONE has the ability to skip beats and use the data from just a single beat to provide high-quality diagnostic images in the majority of patients.

Atrial Fibrillation

Heart rate during scan = 63-113 bpm

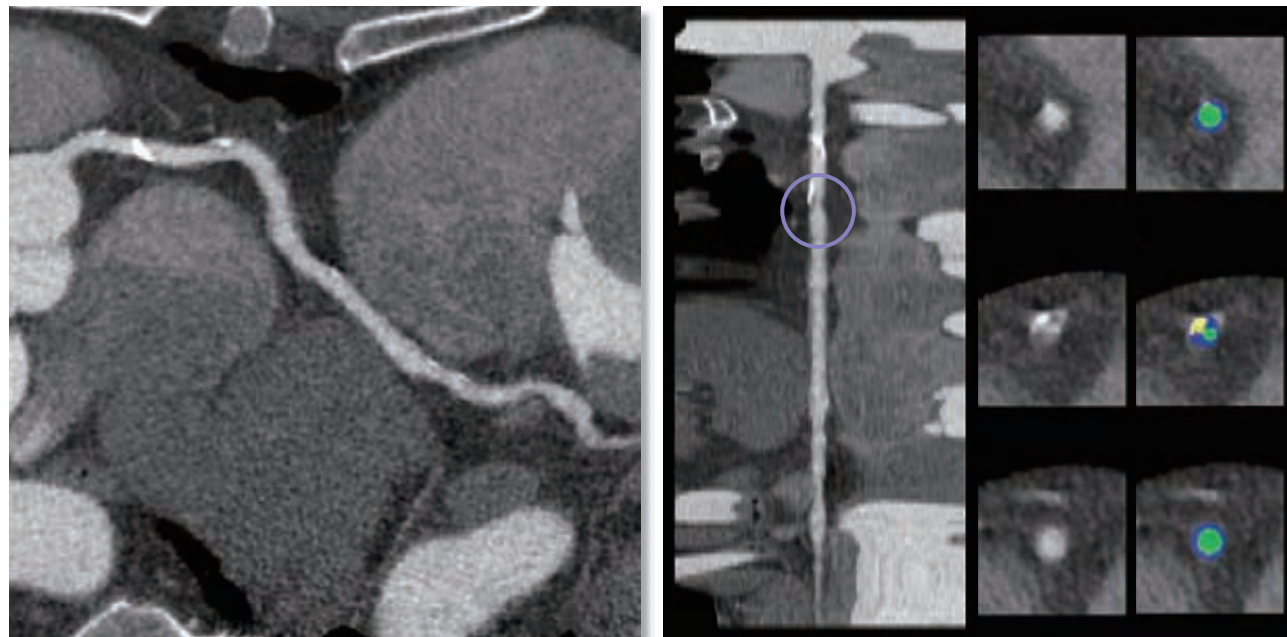
Introduction

This 71-year-old man presented with various risk factors for coronary artery disease, including diabetes, hypertension, and symptoms of angina. A CT scan was requested to rule out ischemic heart disease.

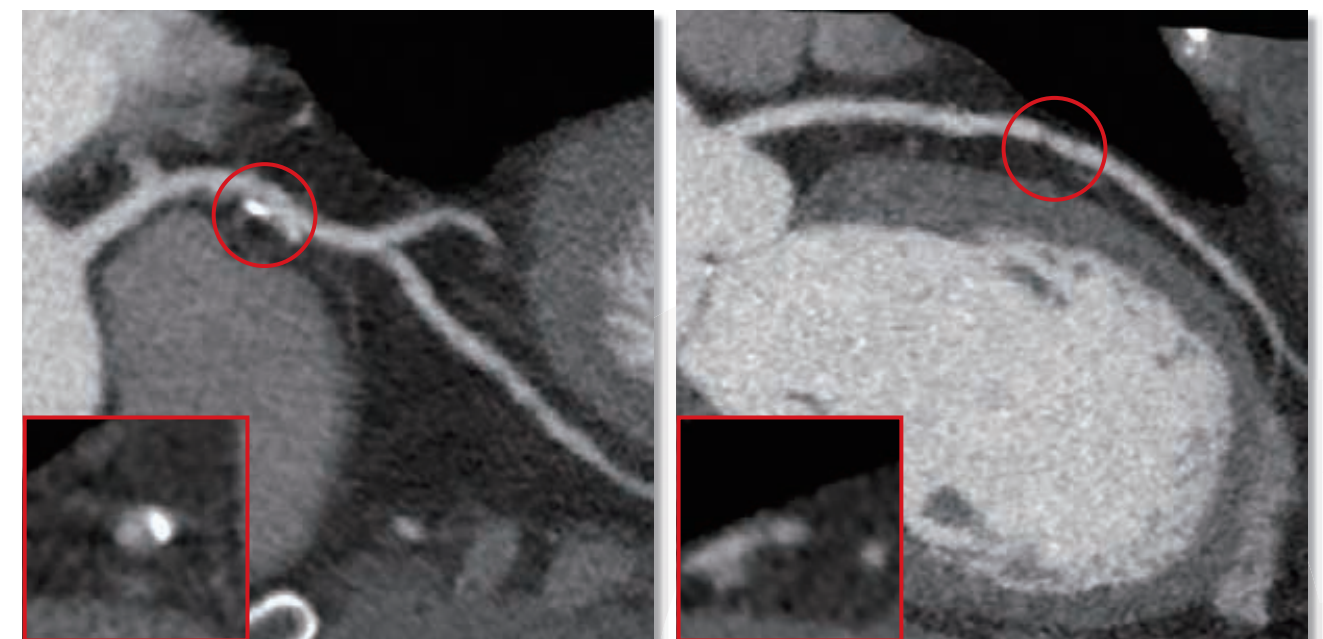
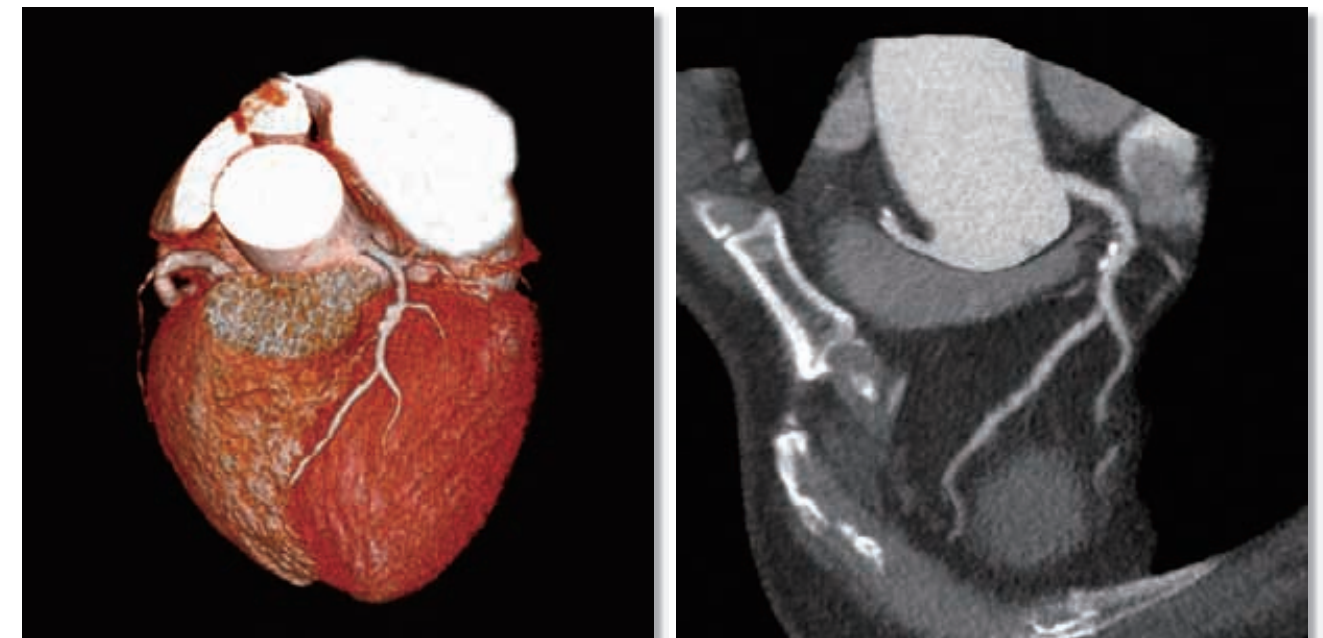


The patient experienced atrial fibrillation while in the scanner, as seen in the irregular ECG trace recorded during this multisegment 2 beat scan.

Findings



A mixed lesion is seen in the mid RCA in these MPR images. The stenosis was considered to be greater than 50% but not more than 70%. SUREPlaque™ software shows the lesion to contain both calcified and noncalcified components.



In these MPR images, a stenosis is demonstrated in the proximal LAD. It contains both calcified and noncalcified regions. The lesion was considered to be causing less than 50% stenosis. There is also a noncalcified plaque in the mid LAD immediately distal to the origin of the first diagonal branch. This lesion is causing greater than 50% stenosis.

Conclusion

Multiple lesions causing significant stenosis are seen in the LAD and RCA in this case.

Atrial fibrillation is one of the causes of a variable heart rate. This example demonstrates that by ignoring the fast beat, diagnostic images can be obtained by performing multisegment reconstruction for the slower beats.