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Leading Innovation >>>

Cardiac Imaging

Clinical Flexibility through Advanced Technology

ONE
Aquilion
dynamic volume CT

Case Study Brochure

Mount Elizabeth Hospital



TOSHIBA MEDICAL SYSTEMS CORPORATION

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ONE
Aquilion

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Clinical Flexibility through Advanced Technology

Introduction

Mount Elizabeth Hospital is a private acute tertiary care hospital with 505 beds that provides a full range of radiology services to more than 375 medical specialists in the adjoining medical center, which includes Asia's highest concentration of cardiologists and cardiac surgeons, neurologists, and neurosurgeons. The CT center is an outpatient facility that has performed more than 8000 cardiac scans to date.

Our site began performing coronary CT angiography back in 2004 with a 16-row MDCT system. Although the results were impressive for that time, the limited temporal and spatial resolution of this technology precluded the routine clinical use of coronary CTA.

The installation of an Aquilion™ 64 system in 2005 demonstrated clear advances in CT technology that directly benefited coronary artery imaging. Not only could images be acquired with isotropic spatial resolution in a shorter breath-hold time, but the procedure also became very robust, particularly with routine premedication with oral beta-blockers. As a result, our patient referral base grew, and our second and third Aquilion 64 systems were installed in 2006 and 2007. Additionally, our site participated in the CorE64 international multicenter trial led by the Division of Cardiology at Johns Hopkins. These results were published in the New England Journal of Medicine in November 2008.

Earlier this year, we installed a system that incorporates the latest advances in CT imaging. The Aquilion ONE™ system, with its ability to capture the entire heart in ONE rotation, demonstrates dramatic advances in achieving robust cardiac imaging in a wider variety of patients at reduced patient exposure doses.

Our site employs Prospective CTA scan mode successfully in 85% to 90% of our patients. This scan mode exposes a small portion of ONE heartbeat to obtain a reconstructed volume acquired at the same moment in time.

Another advantage of Aquilion ONE is its clinical flexibility in patients who were a challenge to image using a 64-row MDCT system. For example, what happens in patients with high heart rates or high calcium scores or those who are unusually anxious about the examination? I would like to present ways to overcome these clinical challenges by sharing our experience with this advanced technology in actual clinical cases.



Dr. Robert Kwok, Medical Director



Dr. John Hoe, Clinical Director

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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.

Ultra-Low-Dose Prospective CTA

Introduction

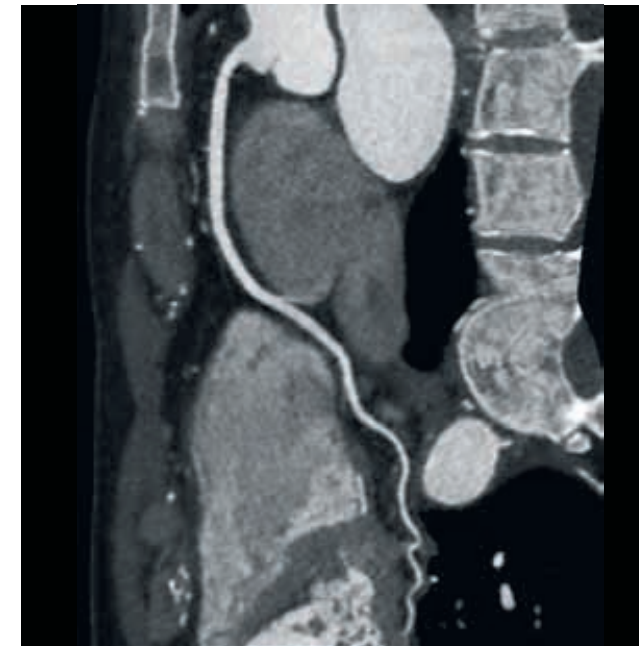
Aquilion ONE's prospectively triggered scan mode exposes only a small portion of a heartbeat, permitting whole-heart CT angiography to be performed with a low exposure dose.

The following case is a patient who presented with a heart rate of 52 bpm. Since coronary artery disease was not strongly suspected and functional imaging was therefore not required, a Prospective CTA scan mode was selected. Toshiba's ^{SURE}Cardio™ software set an exposure window of 62%-82% of one heartbeat. Such a narrow exposure window allows a small range to be reconstructed, so the best, motion-free cardiac phase can be freely selected.

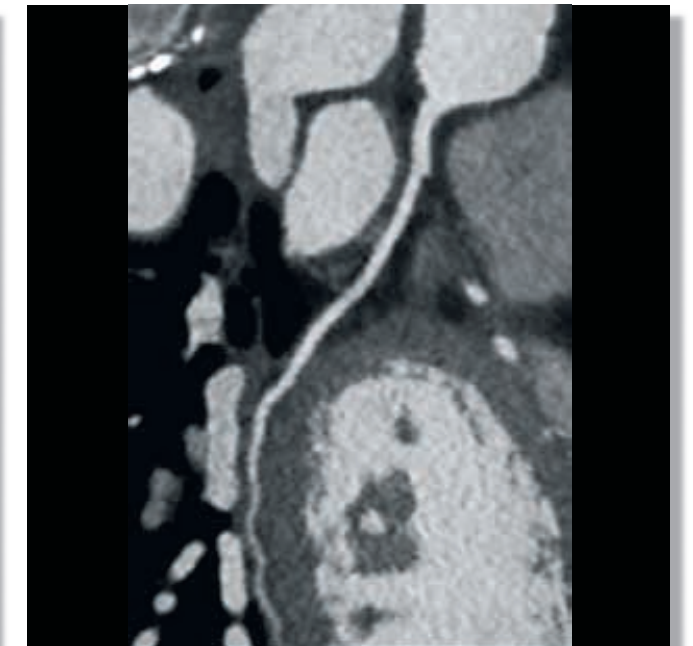


Scan parameters of 80 kV and 500 mA were selected based on the patient's BMI of 18.

The effective dose for this scan was just 1.7 mSv.



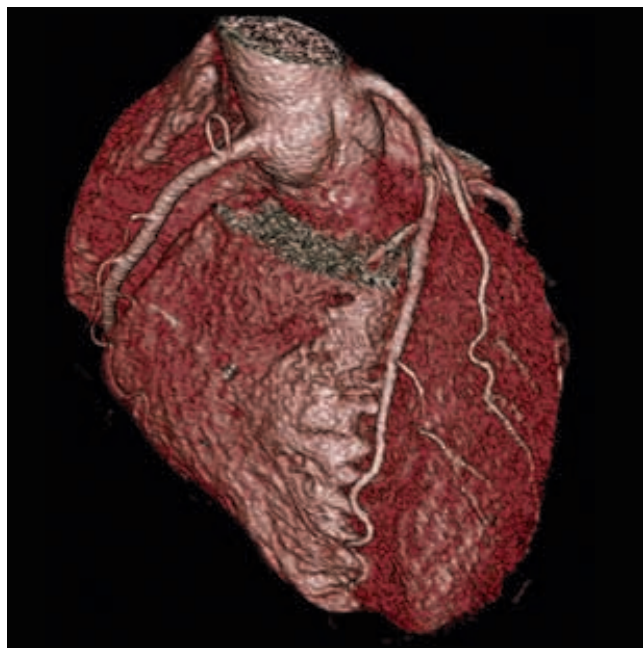
This curved reformation of the right coronary artery demonstrates a normally patent vessel.



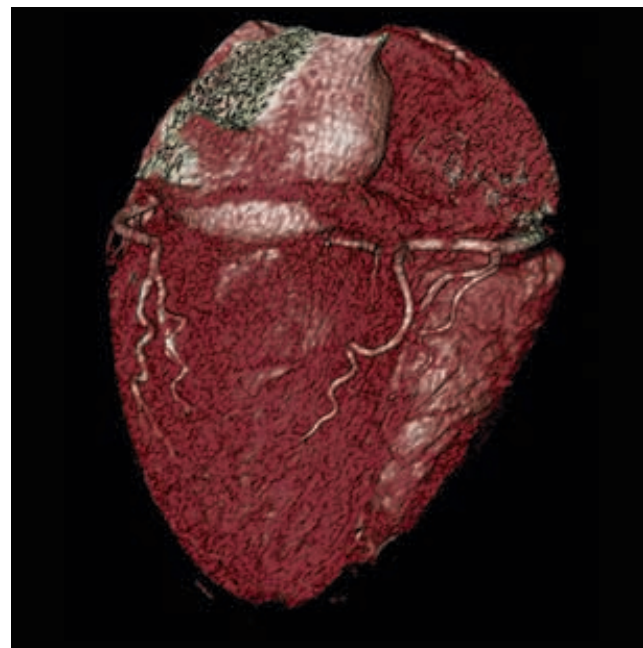
No stenosis or plaque formation is seen in this curved reformation of the circumflex branch.

Patient History

This 51-year-old woman consulted a physician for chest pain atypical for angina. CT coronary angiography was requested to rule out coronary artery disease.



3D volume rendering provides an excellent roadmap of the coronary artery anatomy.



The left circumflex branch is shown to be dominant in this inferior view.

Conclusion

Employing the prospective triggering technique with Aquilion ONE and capturing the entire heart in less than one heartbeat make it possible to perform routine low-dose imaging.

In this case, the use of an 80-kV protocol in a patient with a BMI of 18 allowed scanning to be performed with an exposure dose of only 1.7 mSv. The excellent image quality obtained in this case clearly demonstrates that reducing the kV is effective for minimizing the exposure dose while producing high-quality diagnostic examinations.

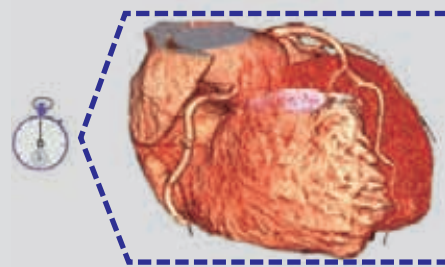
Coronary artery disease could be ruled out in this patient in a fast, efficient, and noninvasive manner with minimal X-ray exposure and a small contrast medium dose.

Prospective CTA in Patients with Severely Calcified Arteries

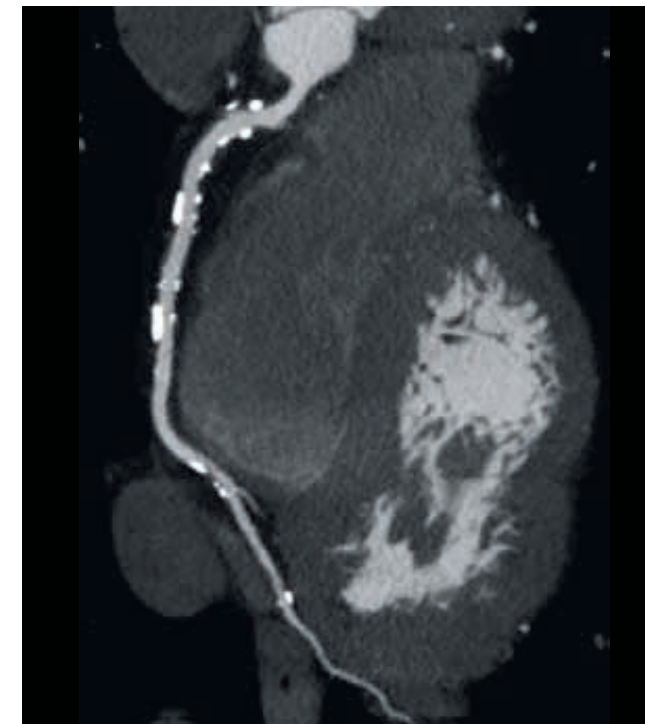
Introduction

Patients with severely calcified arteries have traditionally been a challenge for coronary CTA performed using MDCT. Accurate luminal evaluation is difficult in such patients due to artifacts from calcifications.

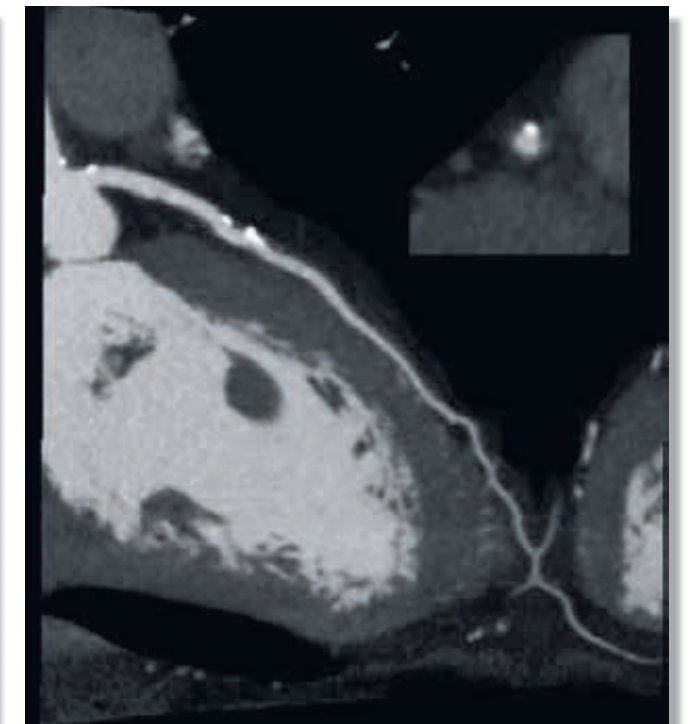
Aquilion ONE captures the entire heart at one perfect instant in time, eliminating artifacts due to interbeat variability and temporal mismatch and thus greatly improving the visualization of calcified plaque. The unique whole-volume temporal uniformity combined with the industry's best 0.5-mm quantum detector configuration leads the field in producing highly diagnostic images.



The patient's calcium score is 2673.



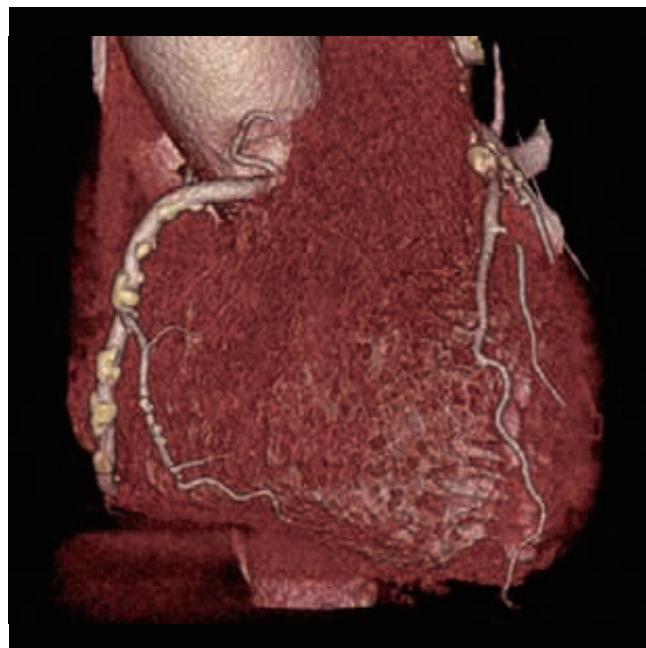
This curved reformation of the RCA demonstrates clearly defined calcified lesions, providing an unobstructed view of the arterial lumen.



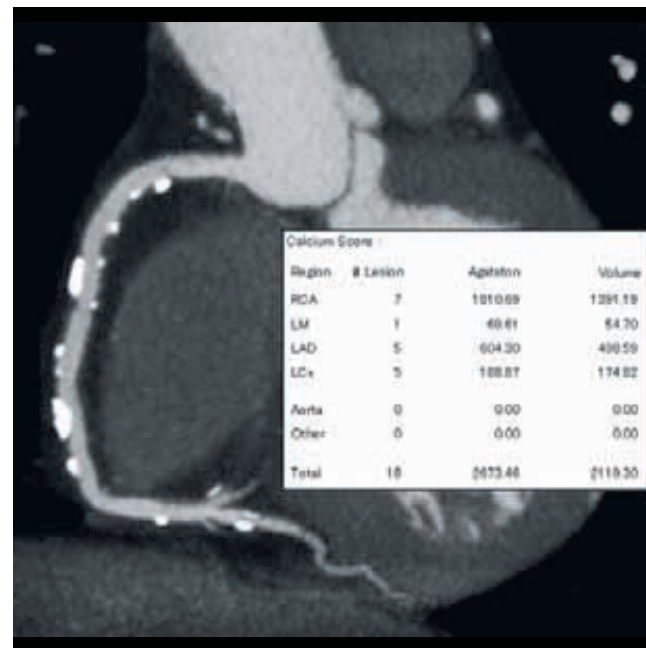
A mixed plaque is demonstrated in the proximal LAD, as shown in the curved reformation and cross-sectional images.

Patient History

This 71-year-old man was referred for atypical chest pain. A CT scan was requested for further noninvasive evaluation.



This 3D volume-rendered image shows several large calcified plaques (displayed in yellow) along the length of the RCA.



The results for the calcium score (Agatston score of 2673) is superimposed on the Cath View of the RCA.

Conclusion

Artifacts from high-density structures such as calcium in rapidly moving coronary arteries may occur for several reasons. These include partial volume averaging, temporal nonuniformity, and inadequate reconstruction algorithms.

Aquilion ONE has clear advantages in overcoming and eliminating artifacts that can obscure luminal visualization and interfere with diagnosis.

Capturing the entire heart in one volumetric acquisition provides images at exactly the same instant in time. This perfect temporal uniformity has clear advantages in producing motion-free coronary artery images. In addition, the unique 0.5-mm detector configuration combined with the coneXact™ reconstruction algorithm reduces partial volume averaging and the artifacts associated with wide cone angles, resulting in a volumetric spatial resolution down to 350 microns.

As demonstrated in this case, high calcium scores no longer need to preclude patients from having coronary CTA.

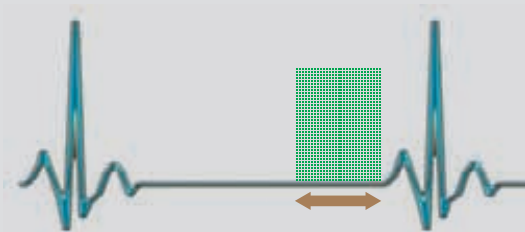
Ultra-Fast Cardiac CTA

Introduction

The ability to capture the entire heart in as little as one rotation permits low-dose cardiac CTA, and equally importantly, reduces scan times to mere milliseconds.

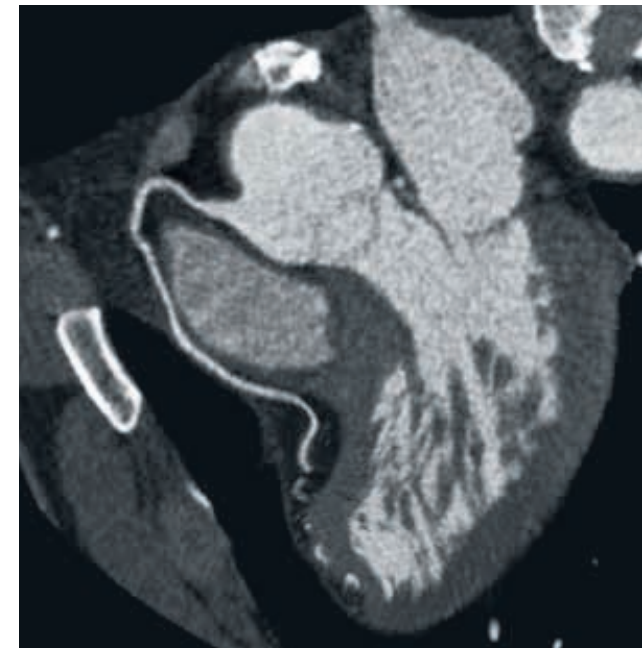
Prospectively triggered CTA scan mode automatically sets a small scan window depending on the patient's heart rate. In patients with heart rates below 65 bpm, this scan window is set to expose the mid-diastolic phase only. The total scan time in this case is a fraction of one heartbeat.

Ultra-short scan times directly contribute to increased patient comfort and permit patients with poor breath-holding ability to be examined.



Scanning in a fraction of one heartbeat

The scan time for this examination was just 450 ms.



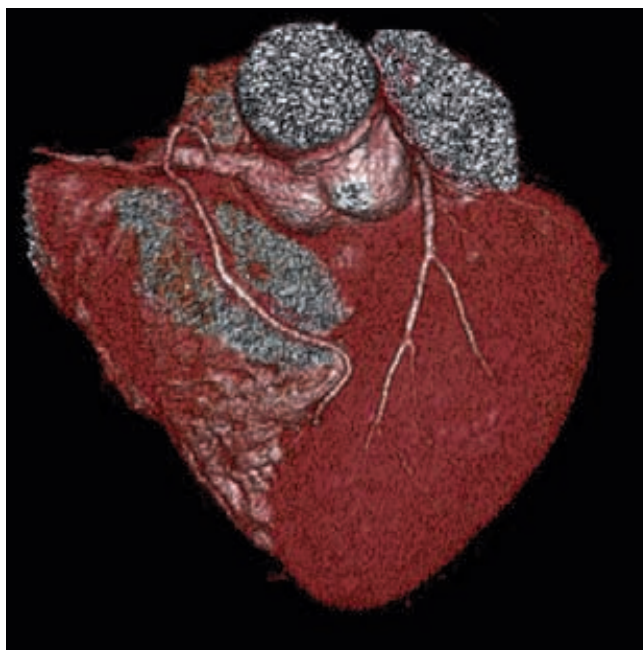
This curved reconstruction shows a small duplicated partial LAD arising directly from the RCA following a course anterior to the pulmonary trunk.



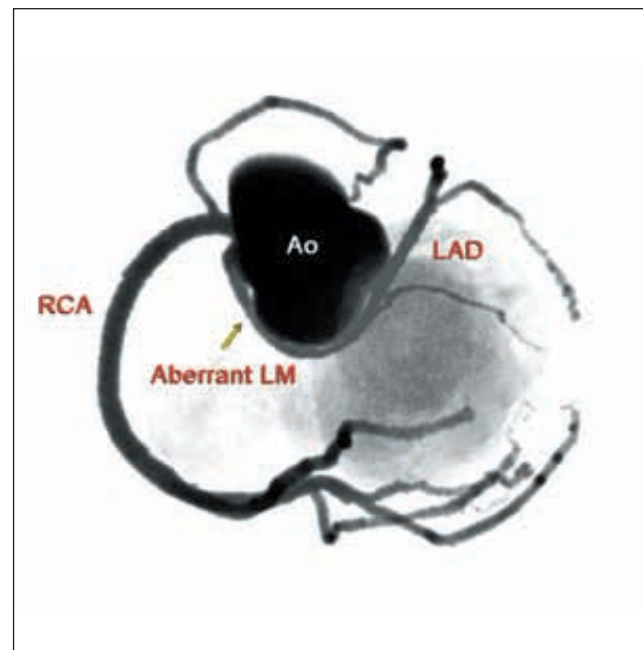
The retroaortic path of the LAD artery arising from the right coronary sinus is shown in this curved planar reformation.

Patient History

This 34-year-old man presented for the evaluation of chest pain on exertion that was not typical for angina. The patient had a strong family history of heart disease and also suffered from hypercholesterolemia.



This 3D image of the heart clearly shows the absence of a normal left main coronary artery and its branches.



The LAD branch arises directly from the RCA.

Conclusion

This patient was understandably very anxious at the prospect of undergoing examination. The ability to perform the examination quickly with a short breath-hold time certainly made the procedure considerably more pleasant. The ultra-fast scan performed in less than half a second provided excellent depiction of this rare anatomical variant.

In this patient, the LAD arises directly from the RCA and follows a path behind the aorta and between the aorta and left atrium. The retroaortic course of the left main coronary artery, which arises from the right coronary sinus, is not considered to be a life-threatening anomaly.

The more common anatomical variant in which the left main coronary artery arises from the right coronary sinus and follows a course between the pulmonary trunk and the aorta is potentially much more dangerous due to the risk of compression during exertion.

Arrhythmia Rejection

Introduction

Patients with arrhythmias have long been considered to be poor candidates for coronary CTA with MDCT. Aquilion ONE overcomes this problem with its automatic arrhythmia rejection software. Volumetric scanning is the only technology that permits robust arrhythmia rejection algorithms to be used in the routine clinical setting.

The system operates very simply. If an arrhythmic beat is detected during the scan, exposure is terminated and the next normal beat is acquired. Since there is no table movement, the system operates very effectively.

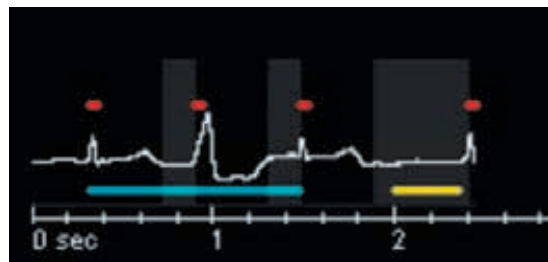


The first beat is arrhythmic, with an unexpectedly short R-R interval. The system can recognize this in real time during the scan and acquires the following beat.

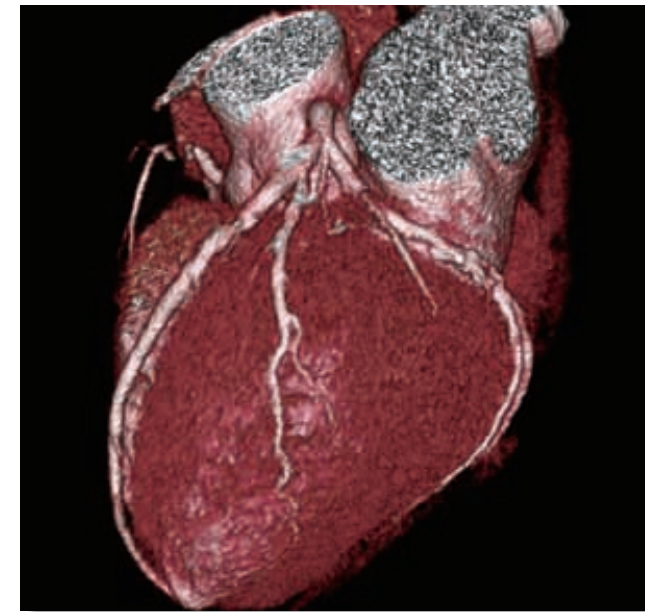
An ectopic beat occurred during this scan.

Patient History

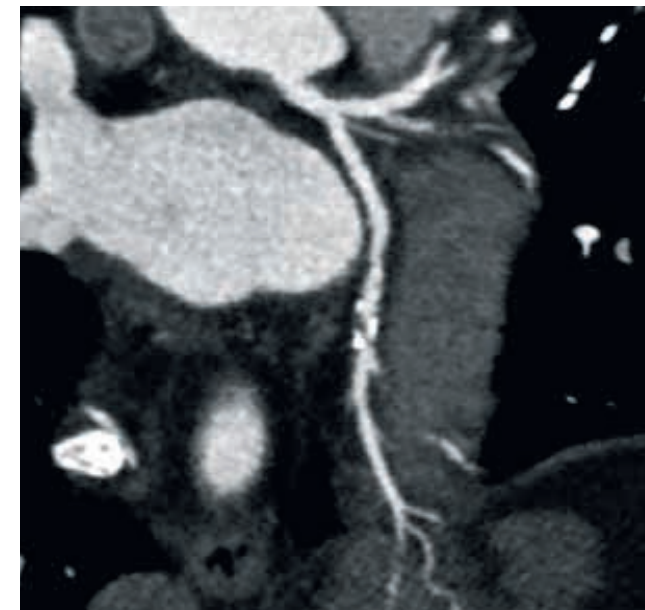
This 63-year-old man presented with atypical chest pain. A CT scan was requested to rule out coronary artery disease.



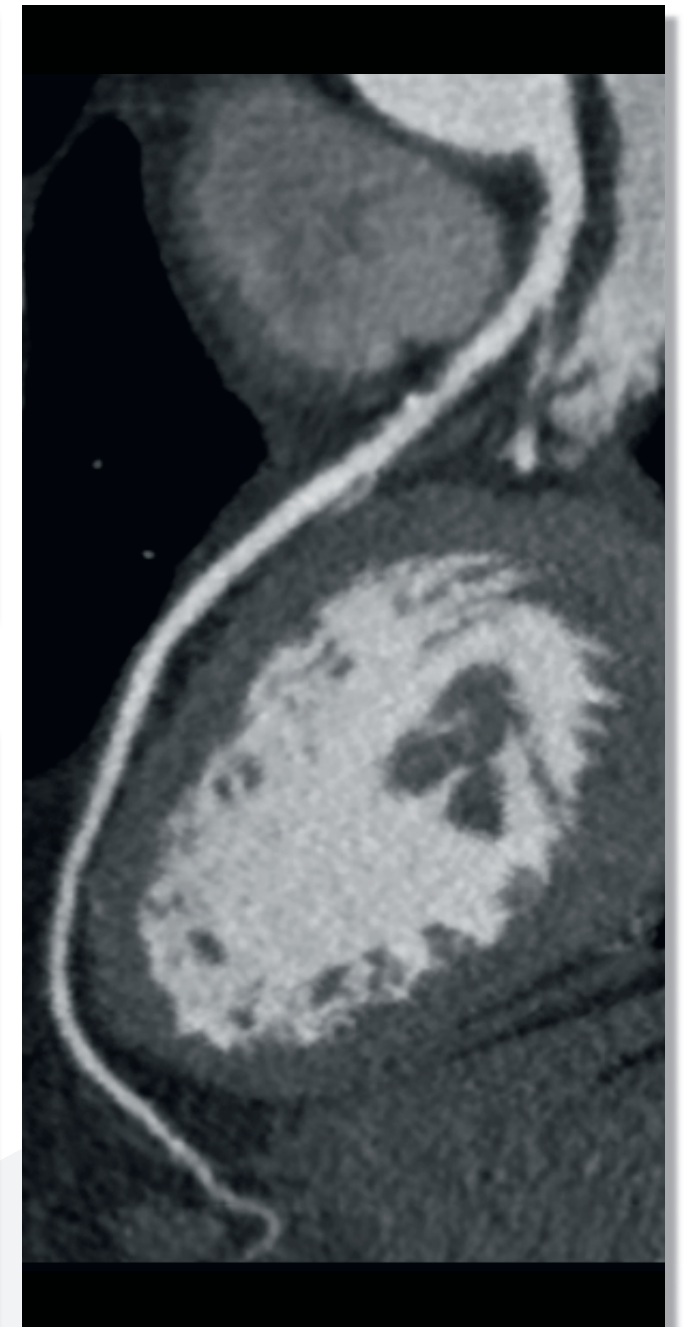
This image is the actual ECG recording during the scan. The light-gray areas represent X-ray exposure. In this prospective CTA scan, a PVC occurred during the first beat. The second beat was also abnormal. In the first two beats, exposure was started, but was immediately terminated by the system when the R wave arrived early. The scanner used the third, normal, beat for reconstruction.



Irregularities of the LAD and circumflex branches are clearly seen in this 3D volume-rendered image.



A severe stenosis of the mid circumflex branch is demonstrated in this curved planar image.



A noncalcified plaque causing stenosis of approximately 50% is demonstrated in the proximal LAD.

Conclusion

Aquilion ONE with automatic arrhythmia rejection software was able to produce a fully diagnostic examination in this patient despite an abnormal cardiac rhythm during the scan.

This advanced technology spared the patient from additional X-ray exposure and a higher contrast medium dose because a repeat examination could be avoided.

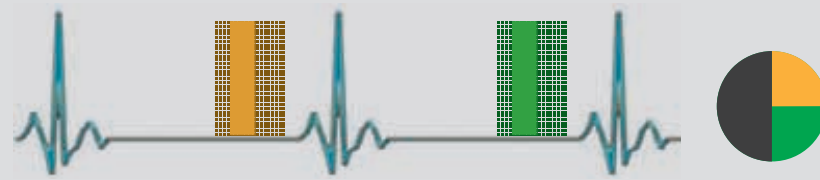
Significant coronary artery stenoses were found in this patient who was considered unlikely to have coronary artery disease.

Adaptive Multisegment Reconstruction

Introduction

Temporal resolution is a term that has become well known through the introduction of coronary artery imaging with CT. It refers to the period of time used for image reconstruction. Aquilion ONE has an immediate advantage in that the temporal resolution does not apply to each individual image, but to the entire cardiac volume.

Half scan reconstruction is the most commonly employed method for improving the temporal resolution. Toshiba's adaptive multisegment reconstruction method takes this basic concept even further to produce images with quarter scan reconstruction or less to further improve temporal resolution. This technique makes it possible to freeze cardiac motion in patients with high heart rates.

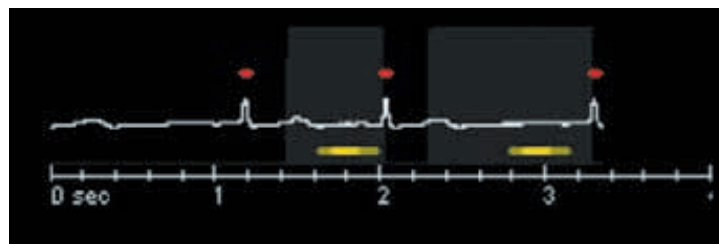


In this example of a two-beat acquisition, quarter-rotation data is used in each beat to reconstruct the cardiac volume with an effective temporal resolution of 88 ms.

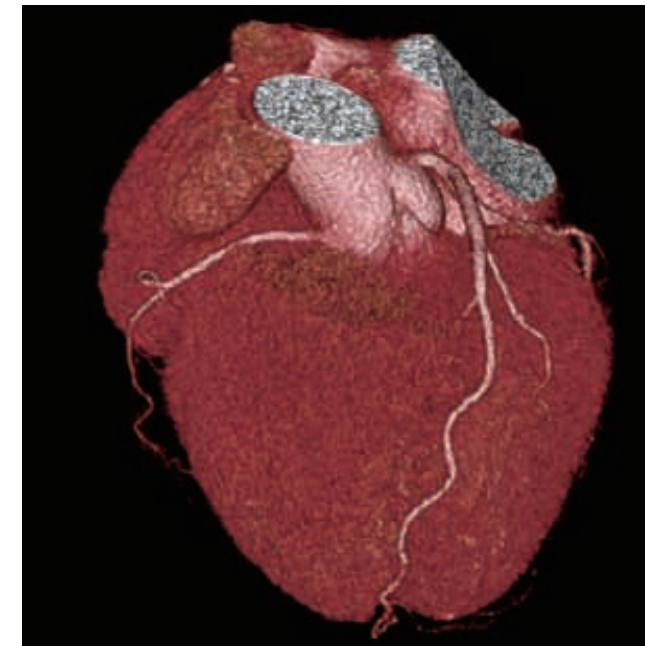
This patient's heart rate varied between 48 and 71 bpm during the scan.

Patient History

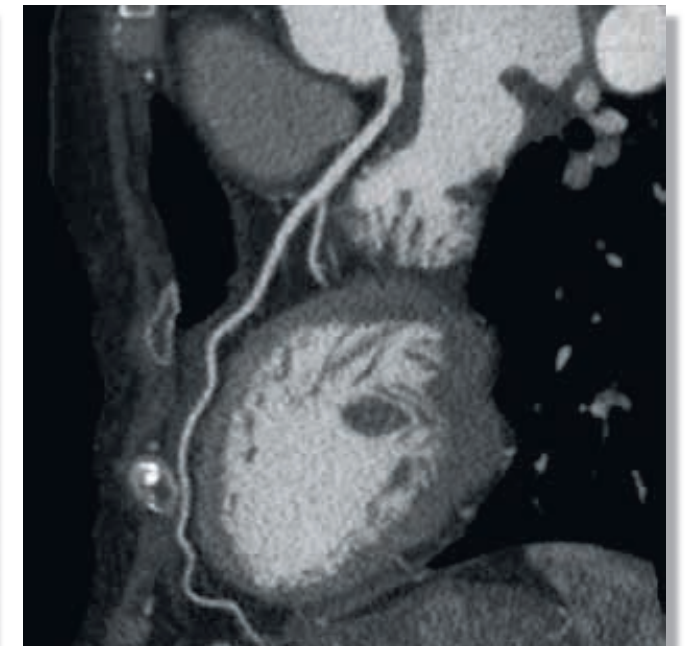
A 63-year old male scheduled for a pacemaker implant to treat sick sinus syndrome was found to have an abnormal treadmill ECG test. The patient was unable to exercise for more than three minutes and became severely short of breath. CT coronary angiography was requested to exclude coronary artery disease.



This image is the actual ECG recording during the scan. The light-gray areas represent X-ray exposure. Due to the patient's highly variable heart rate, the system automatically programmed a two-beat scan. Image reconstruction was performed by adaptively extracting the exact same portion of the cardiac cycle in each heartbeat. This data was then combined to obtain volumetric images with a temporal resolution approaching 88 ms.



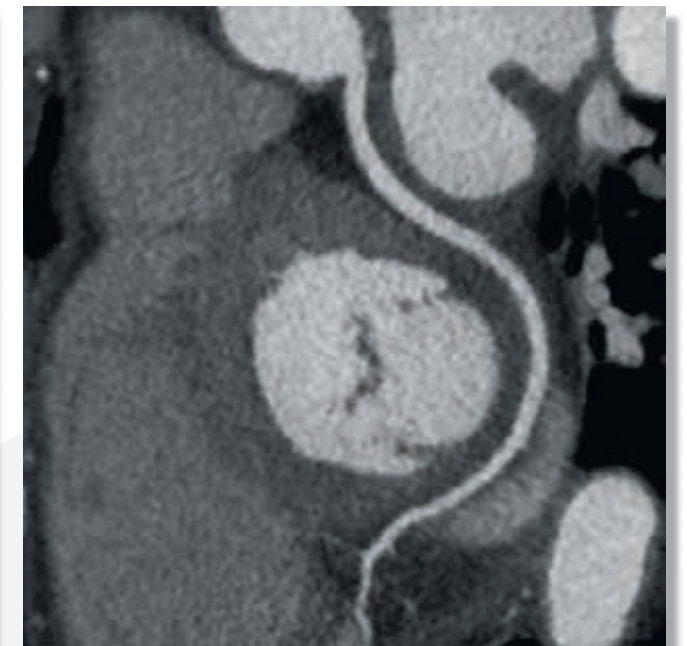
A small nondominant RCA is shown in this 3D image.



The LAD appears normal.



This 3D volume-rendered image shows excellent depiction of the LAD and circumflex branches.



The circumflex branch is large, consistent with a dominant left-sided circulation.

Conclusion

Adaptive multisegment reconstruction has been shown to improve the temporal resolution in patients with high or variable heart rates.

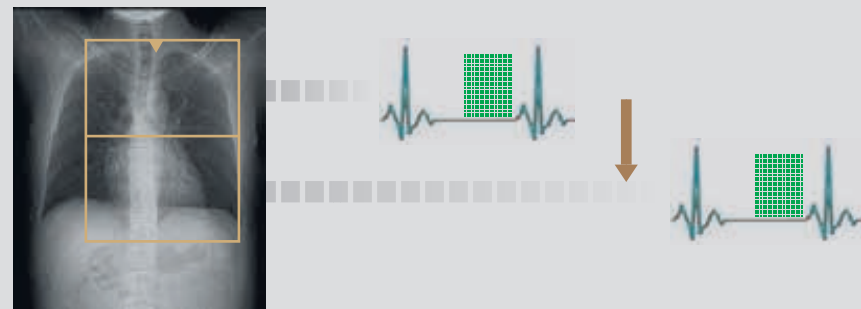
In this patient, the administration of an oral beta-blocker failed to lower and stabilize the heart rate. This is a clinical reality that is faced by imaging specialists on a daily basis. It is therefore important to have sophisticated technology on hand to ensure that a successful examination can be obtained in each and every situation. Coronary artery disease could be ruled out in this patient.

Wide-Volume Scanning

Introduction

The wide 16-cm volumetric scan coverage of Aquilion ONE permits the heart to be imaged easily in one scan without table movement. For bypass graft studies, a new wide-volume scan mode has been developed to maintain the clinical advantages of volumetric acquisition: temporal uniformity with a low-dose acquisition technique.

In this scan mode, two or more separate prospectively triggered volume acquisitions are performed and the data is automatically stitched together during image reconstruction.



This bypass graft study was acquired prospectively in two volumes.

Patient History

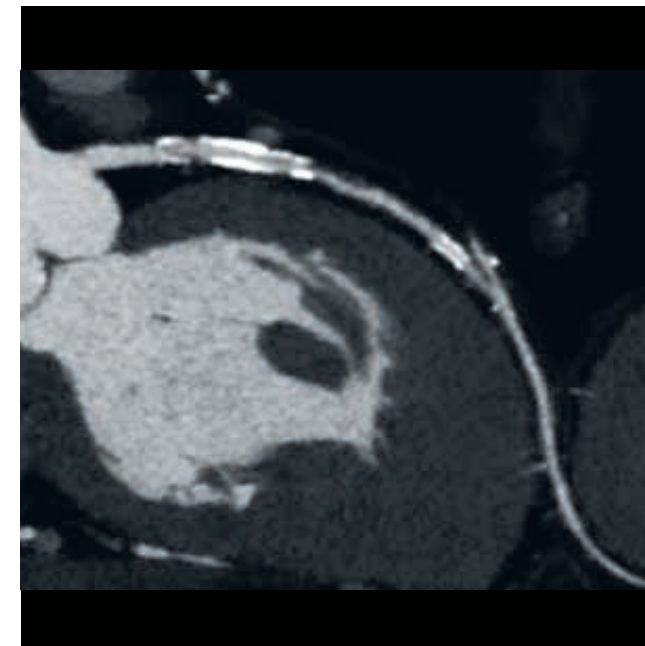
This 63-year-old woman had previously undergone coronary artery bypass grafting. A CT scan was requested to evaluate the grafts following recurrent episodes of chest pain.



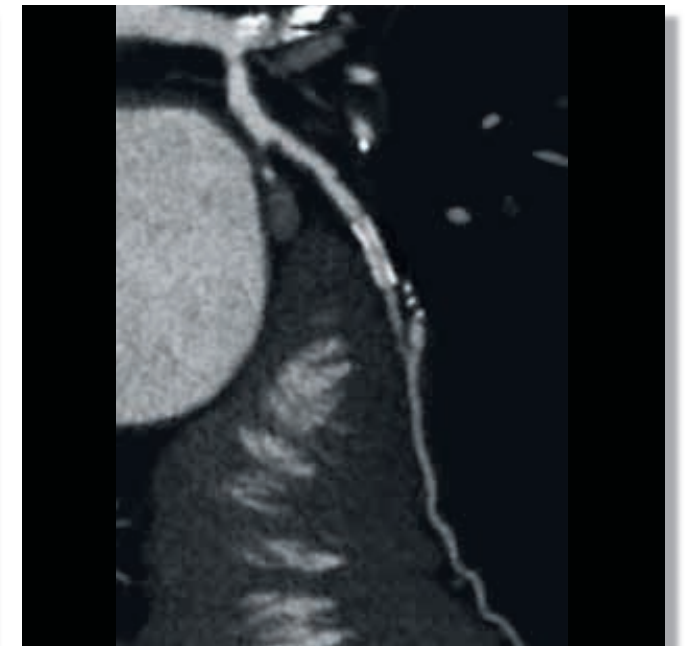
The LIMA-to-LAD graft is shown to be patent. In addition, there is a patent sequential radial artery graft to the obtuse marginal and diagonal branches of the circumflex branch.



The venous graft to the RCA is shown to be occluded at its origin from the ascending aorta.



This curved reformation of the native LAD demonstrates two stents that remain patent. The anastomosis of the LIMA graft to the midportion of the LAD is clearly depicted.



A patent stent is also demonstrated in the native circumflex branch. Excellent filling of the obtuse marginal branch is observed distal to the bypass anastomosis.

Conclusion

Wide-volume gated scanning has been shown to be an excellent method for imaging patients with bypass grafts using Aquilion ONE. This method maintains the low-dose advantages of prospectively triggered volume scan techniques and produces a single stitched image for data analysis. Each acquired volume has perfect temporal uniformity.

In just two acquired heartbeats, this scan was able to cover the entire chest from the origin of the LIMA to below the apex of the heart.

This patient was found to have an occluded RCA bypass graft. The three remaining bypass grafts (a LIMA-to-LAD graft and a sequential radial artery graft to the diagonal and obtuse marginal branches of the circumflex branch) remain fully patent.

Since the entire heart can still be fully captured in the second volume scan, excellent visualization of the native vessels is possible, with no possibility of step artifacts associated with patient movement.