

Coronary CTA Retrospective Protocol: More is Always Better?

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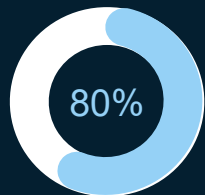
SÍRIO-LIBANÊS

BACKGROUND

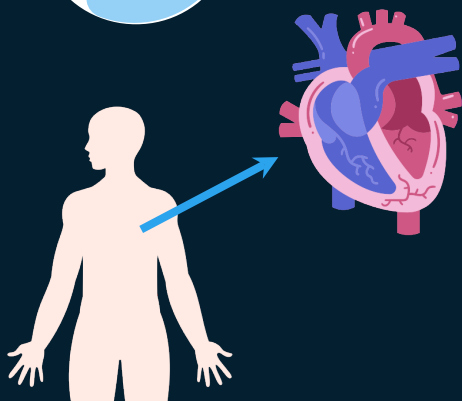


Cardiovascular disease is the leading cause of death worldwide.

Ischemic heart disease is the leading cause of cardiovascular death, accounting for 9.44 million deaths in 2021.



Over 80% of cardiovascular disease is **preventable**



Coronary CT angiography (CCTA) is the main choice for cardiovascular risk stratification

High reliability

High negative predictive value

Non-invasive method






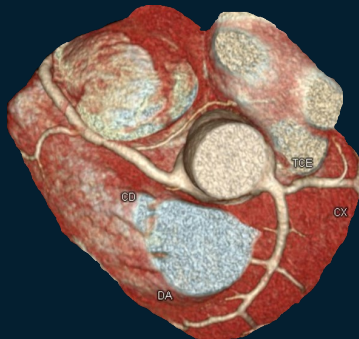
3D CCTA image

BACKGROUND

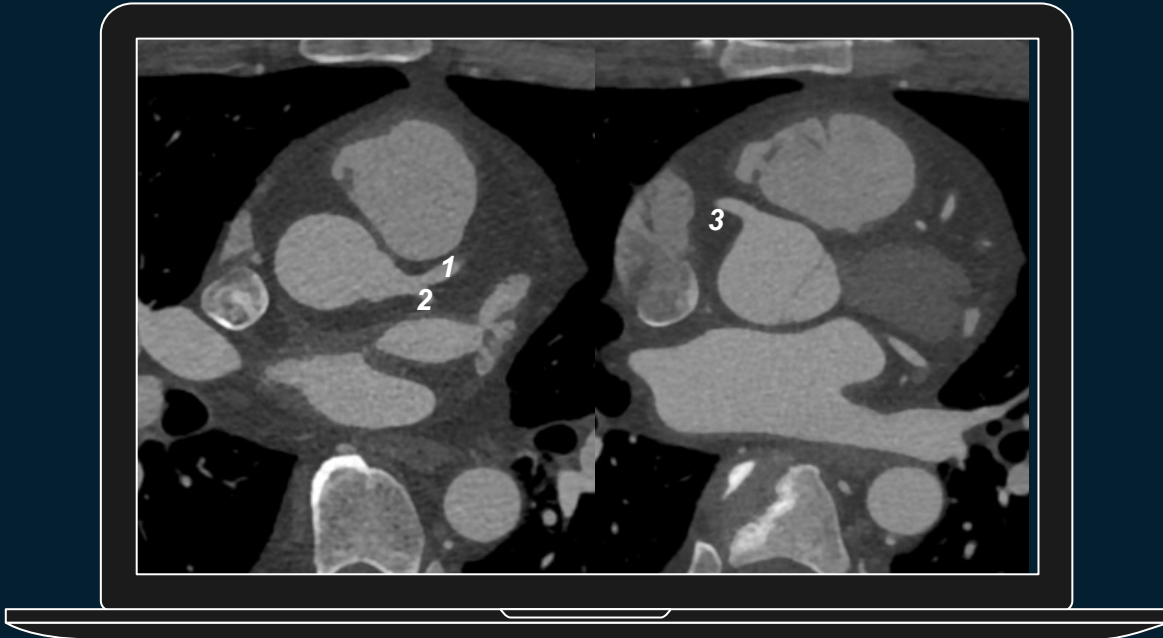
CCTA enables the comprehensive assessment of coronary artery anatomy in its entirety and across three-dimensional planes.

CCTA: Anatomy Evaluation

-  **Anterior descending artery (1)** Supplies majority of left ventricle
-  **Circumflex artery (2)** Supplies left ventricle free wall and portion of anterolateral papilar muscle
-  **Right coronary artery (3)** Supplies right ventricle



3D CCTA image



CCTA axial images

BACKGROUND

Throughout the entire CCTA acquisition process, the subject's ECG is continuously recorded, and image reconstruction is synchronized with heart motion through ECG triggering.



**Retrospective ECG triggering mode
(Helical mode)**



Higher radiation

Radiation projection data from specific points within the R-R interval are selected for image reconstruction



**Prospective ECG triggering mode
(Sequential mode)**

Lower radiation

X-rays are turned only at predetermined R-R intervals



The main challenge in CCTA is to immobilize heart motion to capture images of the coronary arteries throughout the cardiac cycle.

Diastolic phase



High temporal resolution



High spatial resolution



Most quiescent part of cardiac cycle



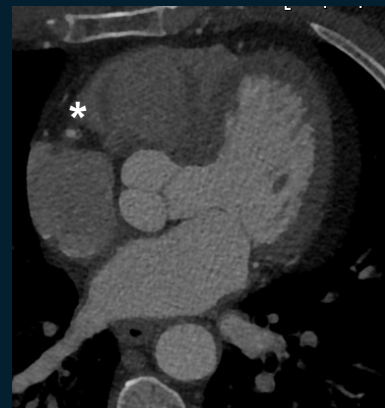
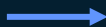
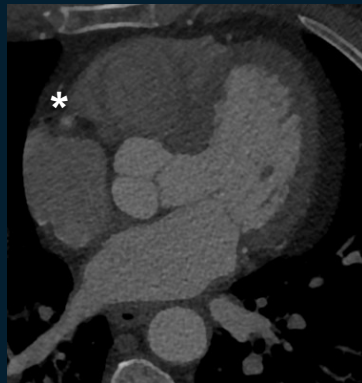
Retrospective ECG triggering (Helical mode)



Prospective ECG triggering (Sequential mode)



Because X- ray is turned all over the cardiac cycle in retrospective ECG triggering method, reconstruction in different phase in R-R interval is possible in cases of *increase heart rate (HR), extrasystoles, arrhythmia or breath motion artifacts*



RCA study was possible when selected a different phase to image reconstruction

CCTA retrospective acquisition and patient ECG. Image on the right shows an artifact due to an extrasystole during image acquisition, compromising RCA (*) study

METHODS

From February 1st to July 31st, adjustments were made to optimize protocols, enhancing the quality of retrospective-mode CCTA images and reducing radiation exposure.



Use of Beta-blocker medications

Reduce patient's HR (longer diastolic phase)

+



Vessel dilator (Isordil)

Improve RCA visualization

⚠️ Contra indications:

Use of PDE-5 inhibitor drugs: sildenafil (Viagra), vardenafil (Levitra) and tadalafil (Cialis) can cause severe hypotension



Succinate metoprolol

Intravenous (IV) or Oral

β1 selectivity

Contra indications:

asthma on beta-agonist inhalers and active bronchospasm



Ivabradine

Oral

selectively suppresses the activity of sinoatrial node cells.

Use of Automatic Exposure Control and BMI patients protocols



Care dose 4D is responsible for tube-current modulation according to different anatomical regions and patient BMI
Care kV provides the requested image quality while minimizing dose to the patient

5 protocols categories according to patients BMI (mAs and kV values according specific for each protocol)

+

Iterative reconstruction (IR)

Algorithms reconstructions developed to overcome filtered backprojection



Higher spatial resolution



Lower image noise

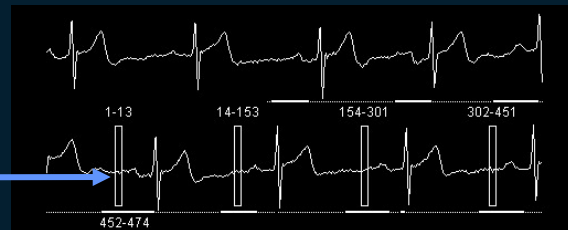
Bv 36 + ADMIRE strength 2 → Bv 40 + ADMIRE strength 3

In retrospective ECG triggering mode scan data are collected throughout the heart cycle



R-R range is the maximum tube current

Phase selected to image reconstruction



Retrospective acquisition ECG. Used 70-80% range and image reconstruction was selected in 75% phase.

Phantom trial using 3 different R-R ranges during a CT ECG triggered acquisition demonstrates differences in DLP values according to different R-R ranges

	Scan	kV	mAs / ref.	CTDIvol* mGy	DLP mGycm	TI s	cSL mm
T ARR 70-80	32D	110	208 /340	58.58 L	2058.3	0.25	0.6
T ARR 60-80	33D	110	238 /340	66.93 L	2351.6	0.25	0.6
T ARR 40-80	34D	110	280 /340	78.78 L	2768.1	0.25	0.6

Larger R-R range

Longer exposure to maximum tube current

Higher DLP

In 120 CCTA examinations, we observed the average phase chosen by CT scanners during retrospective mode acquisitions at varying heart rates on two dual-source CT scanners:

Flash: 74% and Force: 70% (Siemens)



Established R-R ranges according to average phase selected observed



Flash: 67%-80%
Force: 70% -80%



Team awareness (physicians, techonogists) about the radiation exposure increase when selecting larger R-R ranges

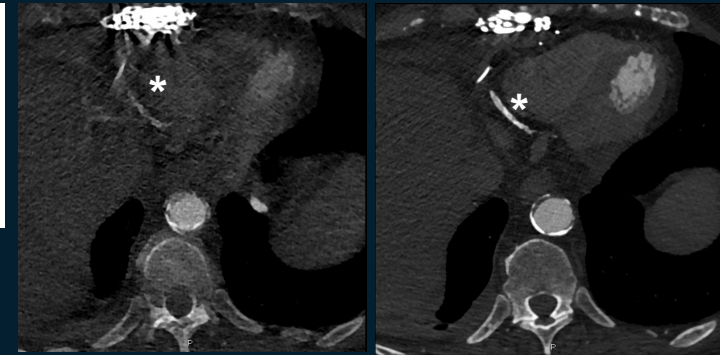
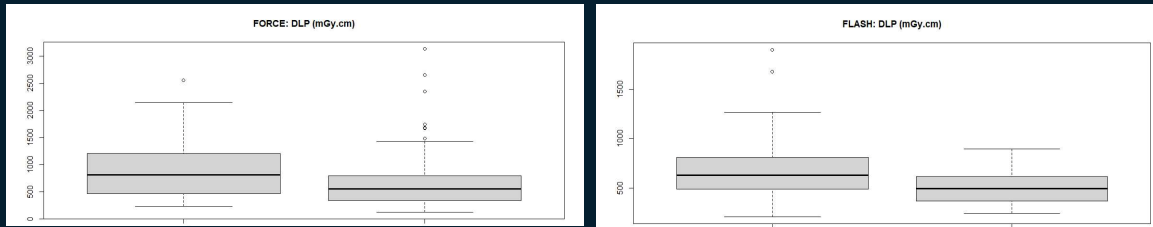
RESULTS



Fixed R-R ranges in retrospective acquisition mode

✓ As a result, we noted a decrease in the DLP during retrospective CCTA acquisitions after implementing shorter R-R intervals for both dual-source CT scanners employed for CCTA examinations.

✓ Optimizing the retrospective protocol parameters led to enhanced image quality and a decrease in patient radiation exposure during CCTA examinations.



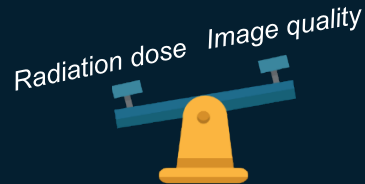
Boxplot graphics showing DLP values before (left) and after (right) R-R ranges alterations in CT dual source scanners (FORCE and FLASH). After established shorter R-R ranges, the graphics indicate DLP median values reduction, from 600 to 400mGy.cm and more concise values around the new median DLP values.

CCTA retrospective acquisition with breath artifact compromising RCA (*) study. After selecting a different reconstruction phase according to the established R-R range, a new image was obtained without artifacts in RCA. There was no need to repeat the acquisition and media contrast re-injection



**Take
home
messages**

What is the main objective?



How can we achieve it?

*Team awareness and education and
protocol parameters optimization*



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Thank You!

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