

# Flash Cardiac Imaging of the Coronary Arteries

Student Researcher: **Cierra Yonchik**

Faculty Advisor: **Gina Capitano M.S.,R.T. (R)**

Internship Mentor: **Arthur Gialanella M.S.,R.T. (R) (CT)**

Internship Site: **Geisinger Wyoming Valley Medical Center**

## What is Computed Tomography(CT)?

“CT, is the process of creating a cross-sectional tomographic plane of any part of the body. During a CT examination , a patient is scanned by an x-ray tube rotating around the body part being examined ”

(Long, 206, p.302).

## What is Traditional Cardiac Computed Tomography Angiography (CCTA)?

- CCTA is a CT scan utilized **solely to evaluate the heart structures**
- Traditional CT scanners utilize a **single source** multidetector scanner
  - CT machine is constructed with one x-ray tube and one detector array that rotates around the patient
  - Single source scanners are usually 64-slice machines
- Patients are attached to an electrocardiogram (ECG) that is linked to the CT scanner to track heart rate and heart rhythm
  - This process is termed as gating in CT
- During the scan, patients are injected with iodinated contrast media to better visualize vascular structures
- Traditional CCTA's can be acquired in two methods: **prospective sequential and retrospective spiral**
  - Method dependent upon patient's heart rate and heart rhythm; determined by the technologist
- This scan is an alternative noninvasive procedure to detect and treat cardiovascular disease (CVD)

(Machida et al., 2015).

## Prospective vs. Retrospective Image Acquisition in traditional CT

### Prospective Sequential

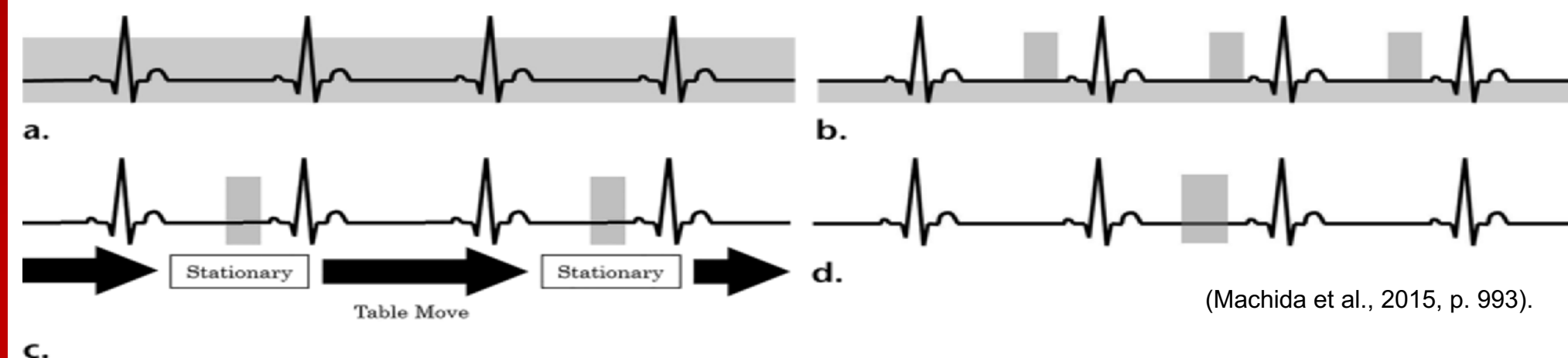
- Also known as partial scan or “step-and-shoot”
- Radiation is delivered throughout multiple consecutive heartbeats then pieced together to create a single image
- ECG signal triggers x-ray tube to scan during the ST-T phase; period at which the atriums and ventricles are at rest; lowest diastolic phase
- Distance the table travels per one rotation of the gantry (Pitch): 1.0mm
- Average radiation dose 400 mGy

### Retrospective Spiral

- Also known as helical scan
- Radiation is delivered continuously acquiring data of entire cardiac cycle
- Data from ECG is reconstructed into one single image based on particular percentage in QRS complexes; usually 70%
  - QRS complex represents when the ventricles are contracted
- Distance the table travels per one rotation of the gantry (Pitch): 0.2 to 0.5mm
- Creates images to evaluate entire heart function
- Average radiation dose up to 1,000 mGy

(Machida et al., 2015).

## ECG's Demonstrating the Different Image Acquisition Processes



(Machida et al., 2015, p. 993).

Diagram demonstrates the different image acquisition processes in traditional and dual-source imaging. The gray highlighted areas indicate when radiation is delivered. Points A,B, and C are traditional image acquisition processes. Point D is dual-source (FLASH) image acquisition process.

- Retrospective spiral ECG-gated scan: Radiation delivered with constant tube current
- Retrospective ECG-gated scan: ECG controlled tube current
- Prospective ECG-gated “step-and-shoot” scan
- Prospective spiral dual-source scan

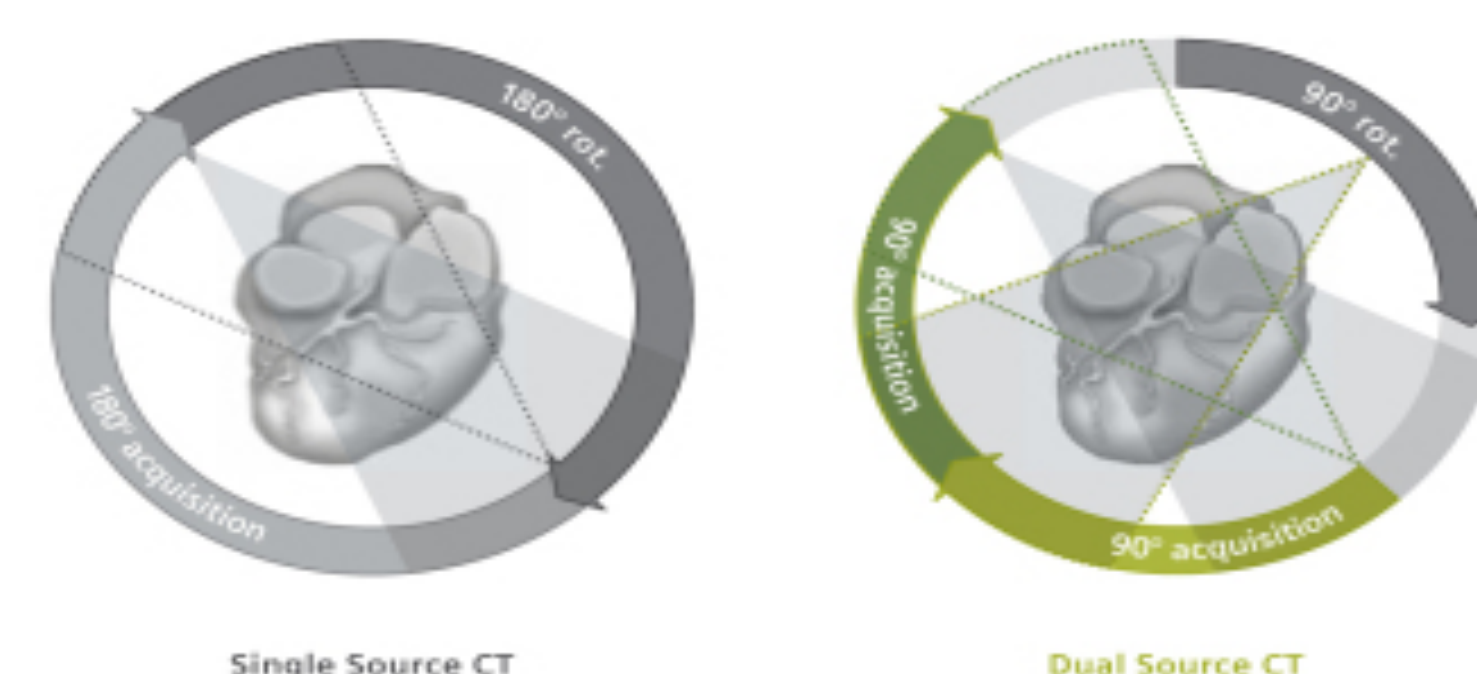
(Machida et al., 2015, p. 993).

## What is Dual Source ( FLASH )Cardiac Imaging of the Coronary Arteries?

- The term FLASH imaging was created by Siemens Healthcare
  - Manufacturer of the Siemens Somatom Force
  - **Dual-Source** CT Scanner: scanner has two x-ray tubes and two detector arrays; the two x-ray tubes are 90 degrees from one another
  - 256-slice scanner
  - Can acquire images twice as fast as single source scanners.
- FLASH in modern CT is credited with being far more superior in the diagnosis and treatment of disease in the coronary arteries
  - Reduced radiation dose
  - Capability to acquire images within a single heartbeat
  - Highly impeccable image resolution

(Smettei et al., 2018).

## Single Source Vs. Dual-Source Acquisition



https://ctscanmachine.files.wordpress.com/2017/05/benefits-of-double-source-ct-scan-devices.jpg?w=798&h=450

## Advantages to Dual-Source (FLASH) Imaging

- Prospective spiral image acquisition
  - Spiral scan that uses a very high pitch; image acquisition in one cardiac cycle of approximately 0.3 seconds
- Same energy used with both x-ray tubes
- 0.2 seconds rotation time of gantry
- Decreased radiation dose; often less than 100 mGy
- Distance the table travels per one rotation of the gantry (Pitch): 3.2-3.4 mm
- Improved image resolution
- Minimal image artifact
- Patient preparation is the same as traditional CT

(Koplay et al., 2016).

## Limitations to Dual-Source (FLASH) Imaging

- Patient must have a **predictable** heart rhythm of 75 beats per minute (bpm) or less
- Patient weight- cannot exceed table weight limit and can slow down the table pitch
- Does not show the hearts function

(Smettei et al., 2018).



https://www.medgadjet.com/wp-content/uploads/2013/12/SOMATOM-Force.jpg

## Patient Preparation Before Imaging the Coronary Arteries in Traditional CCTA and Dual-Source CCTA

- For cardiac monitoring purposes, there will always be a specialized cardiology staff member such as a nurse, nurse practitioner, physician's assistant, or doctor present during the scan to administer necessary medications (most often a registered nurse is present)
- One hour prior to the scan, patients will be required to take 50mg of Metoprolol orally to normalize heart rate (75 bpm or lower)
  - Metoprolol is a type of Beta blocker medication; can be given orally and/or intravenously (IV)
  - If patients heart rate remains elevated, additional beta blockers may be administered
- Iodinated contrast media is administered during this exam to highlight the blood vessels and arteries
  - Must have a large IV access (18 or 20 gauge only) to withstand high injection rates
- Patients are then gated to the CT scanner (ECG monitor that is linked to the scanner)
  - ECG illustrates the cardiac cycle in a unit of time to minimize motion of the heart
  - CT scanner tries to trigger the scan between the R-R waves of the ECG rhythm (60-80%)
  - R-R wave (interval) is the time between QRS complexes; calculates time between two heart beats
  - The R wave is the largest wave on QRS complex; represents electrical signal through the ventricles
- Vasodilator medication (nitroglycerin) given immediately prior to scan
  - Given sublingually by tablet or spray
  - Fast acting medication; dilates vessels to improve visualization

(DuBose et al., 2019).

## Scan Process Once Patient is Prepared

- A scout image is taken to determine what specific parts of the body are being scanned and where to trigger the CT machine to scan once contrast media has reached the region of interest
- Upon formation of the scanning plan, a scan without contrast will be taken of the heart to evaluate for calcium build up in the arteries; also called coronary artery calcium scoring (CACS)
  - CACS evaluates for early diagnosis of atherosclerosis which can reduce future risk of myocardial infarction, stroke, or ischemia
- Upon completion of the CACS and determination of heart rate stability for the best optimal images, the contrast will be injected
  - 300-400 mg/ml of iodine concentrated contrast media (how concentrated the iodine is)
  - 70-150 ml contrast volume (how much contrast is injected)
  - 3-6 ml/s flow rate/ injection rate
  - 150—300 Hounsfield Units (HU) to induce scan; when contrast reaches the region of interest to trigger the scan

(DuBose et al., 2019).

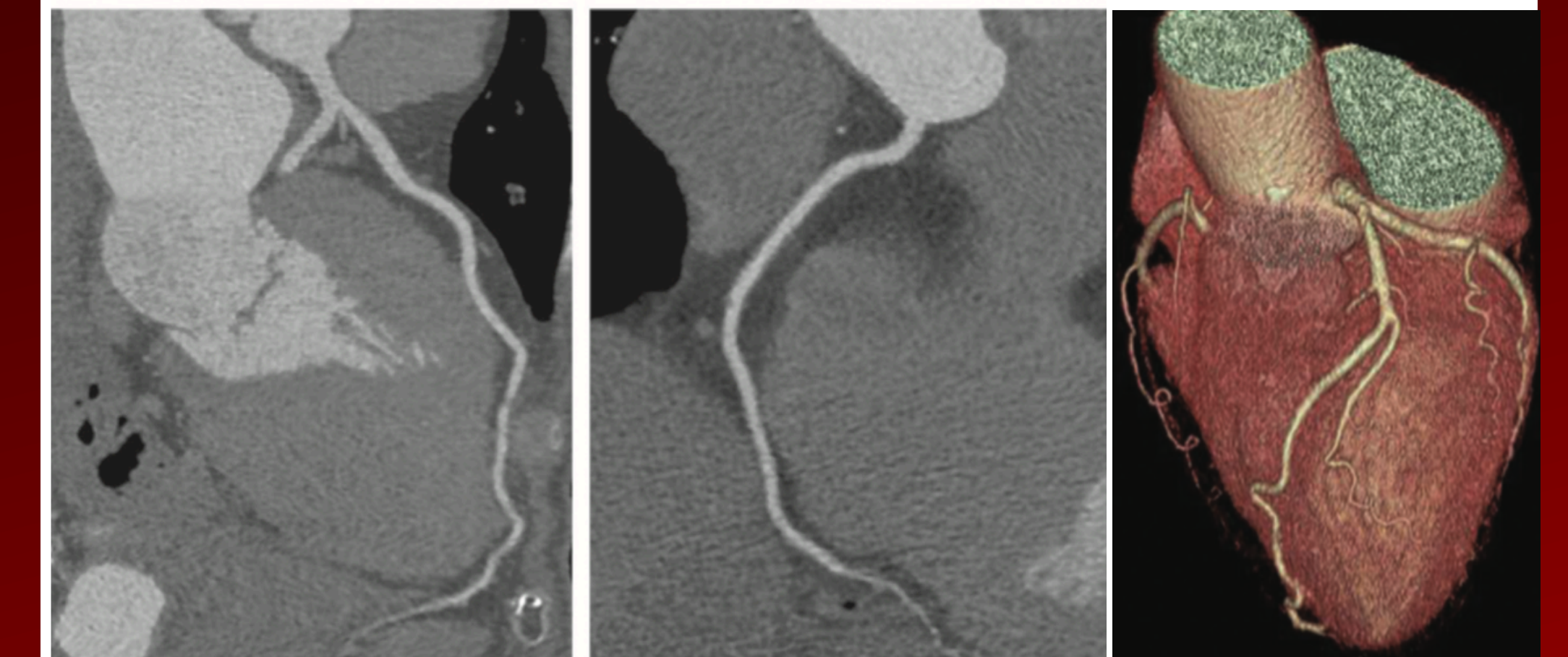
## Why Dual-Source (FLASH) Imaging is The Imaging Procedure of Choice for the Coronary Arteries

Dual-source imaging is becoming the preferred method of choice for the better visualization of the coronary arteries because of advances in modern CT technology. With advances like dual-source scanners, images are captured two times faster than in traditional CT providing highly detailed images for better visualization of vascular structures especially of the heart. Additionally, radiation exposure for patients is drastically reduced.

(DuBose et al., 2019).

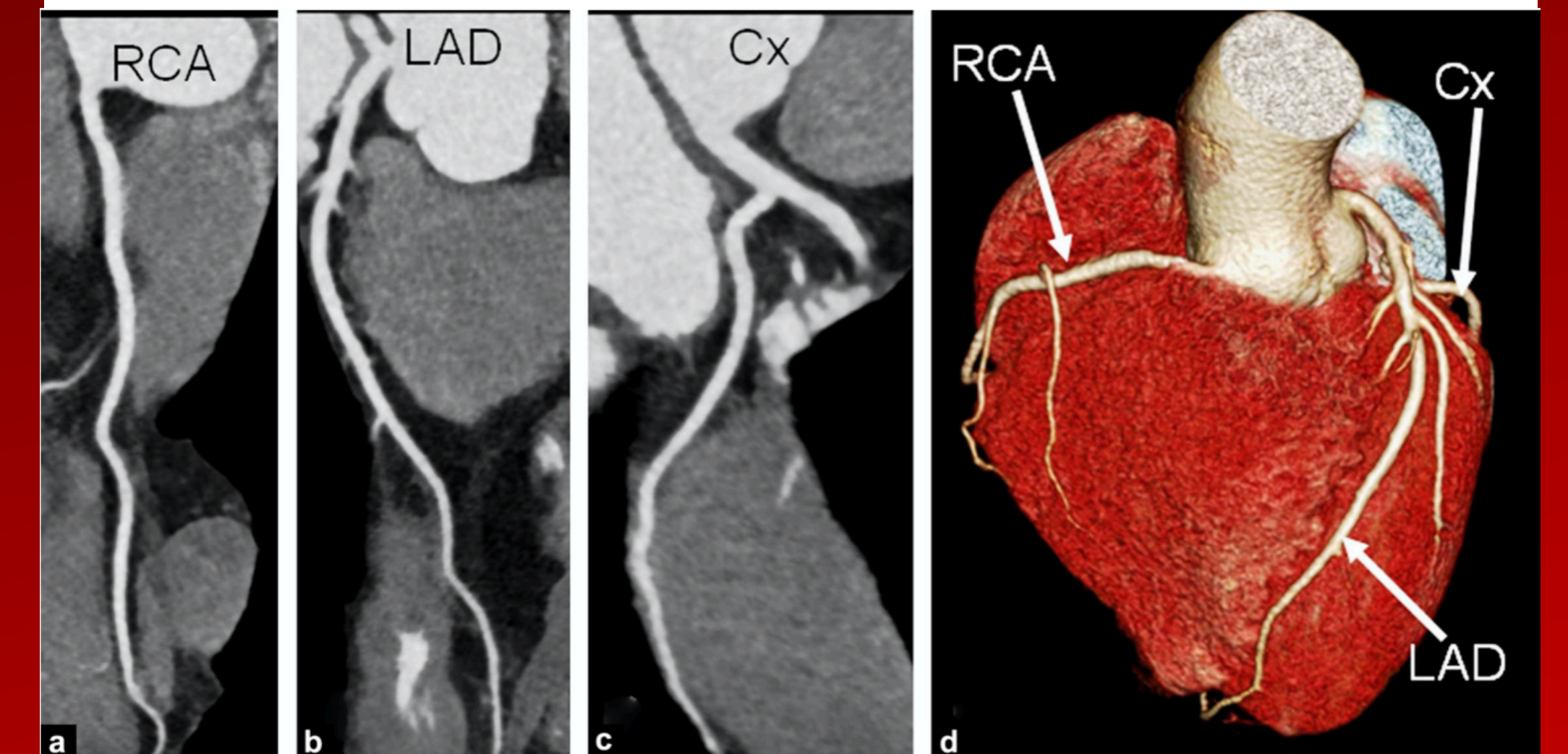
## Traditional Cardiac CTA Images vs. Dual-Source (FLASH) Cardiac CTA Images

### Traditional Prospective Sequential Image Acquisition



(Machida et al., 2016, p.995).

### Dual-Source (FLASH) Image Acquisition



(Koplay et al., 2016, p. 464).

## Why Dual-Source (FLASH) Cardiac Imaging is Becoming Popular in Diagnosing Cardiovascular Disease

- As of 2015, cardiovascular disease accounted for approximately 17.7 million deaths worldwide (DuBose et al., 2019).
  - Number one leading cause of death in the world.
- Approximately 80% of those deaths related to cardiovascular disease, such as atherosclerosis, were initiated from a myocardial infarction (MI) or stroke (DuBose et al., 2019).
  - Build up of fats and other substances in the vessels put patients at a greater risk for MI & stroke
  - With dual-source CT, cardiac imaging specifically of the coronary arteries, can not only detect the potential risk of cardiovascular disease but can aid in early treatment
  - CACS and CCTA with dual-source imaging has greatly reduced the risk of a possible heart attack, stroke, and ischemia
- Radiation dose to patients is immensely reduced with dual-source computed tomography, compared to traditional CT scans
- Dual-source imaging is two times faster than traditional CT scans
  - Allows for ease of imaging structures of the heart within a matter of seconds without producing image artifacts such as motion.
- Since CT contributes to “24% of the population's radiation exposure” (Cupp, 2016, p.169), it is important to be cognizant of the cumulative nature of radiation exposure, making every effort to keep doses as low as reasonably possible
- With CT scanners such as the Siemens Somatom Force, obtaining optimal images with high diagnostic quality at the lowest possible dose is easily achieved
- With advanced imaging such as dual-source (FLASH) CT, early diagnosis of cardiovascular disease can reduce the chances of patients experiencing catastrophic life-threatening events