



By: Suhny Abbara, MD
Assistant Professor,
Harvard Medical School
Director, Cardiovascular Imaging,
Massachusetts General Hospital
Director of Education,
Cardiac MR/PET/CT Program

Cardiac Injection Protocols for Coronary CTA and RV Functional Assessment Cardiac CT Case Studies

Table of Contents

Biphasic Injection Protocol Optimized for Coronary Artery Imaging. (<i>Patient with Normal Coronary CTA.</i>)	2
Triphasic Injection Protocol Optimized to Enhance RV Cavity for Functional Assessment. (<i>Patient with Normal Right Ventriculogram Suspected of Having ARVD.</i>)	3

Biphasic Injection Protocol Optimized for Coronary Artery Imaging. *(Patient with Normal Coronary CTA.)*

The first case is a routine coronary CTA with the focus on the coronary arteries. The patient was a middle-aged male with a family history of coronary artery disease, moderate risk profile and atypical chest pain. The EKG did not indicate myocardial ischemia and there was no enzyme leak. The referring physician was considering invasive angiography to definitely exclude coronary artery disease as the cause of the atypical chest pain. Due to concerns regarding the invasiveness of the procedure and a relatively low likelihood that coronary artery disease was present, a cardiac gated 64-slice coronary MDCT angiogram was performed instead.

The contrast injection protocol in this study is tailored to opacify the coronary arteries during the MDCT acquisition and to wash out the right atrium and ventricle with a saline chaser bolus.

The latter is desired for two reasons. First, if contrast were to remain in the right heart during acquisition, streak artifact may result in image degradation, potentially decreasing the evaluability of the mid-RCA. The streak artifact occurs because of the mixing of relatively dense contrast containing blood from the superior vena cava with in-flowing, non-opacified blood from the inferior vena cava. Secondly, if contrast material is located in the right heart during the scan acquisition, it obviously cannot contribute to the opacification of the coronary arteries—the structures of interest. A higher contrast

Equipment/Contrast	
CT Scanner	Siemens Sensation-64
Contrast Power Injector	E-Z-EM EmpowerCTA®
Contrast	ISOVUE® 370

Injection Protocol: Biphasic Injection

Phase	Flow Rate	Volume	Time
Test bolus	6 mL/sec	20 mL	3.3 sec
Contrast Phase 1	6 mL/sec	72 mL	12 sec
Saline Phase 2	6 mL/sec	40 mL	6.7 sec

volume at a higher rate, therefore, would be necessary to achieve the same opacification as in a patient with washed out right heart and optimal contrast timing.

Because the image quality in this case is excellent and the negative predictive value of coronary CTA in research studies is typically between 95–100%, it could be established that in this patient the chest symptoms were unrelated to coronary artery disease. The patient was spared the invasive angiogram.

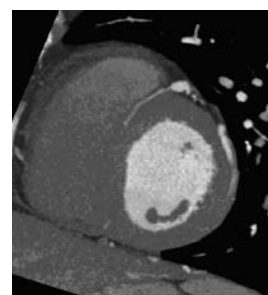


Figure 1. Optimal enhancement of the left cardiac chambers and coronary arteries with no contrast within the right cardiac chambers.



Figure 2. Despite the washout of contrast in the right ventricle, functional evaluation of the ventricular septum is unimpaired.

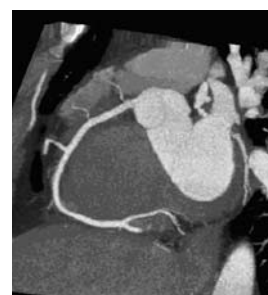


Figure 3. The coronary arteries in this patient are free of any atherosclerotic plaque and no significant stenosis was identified.

Triphasic Injection Protocol Optimized to Enhance RV Cavity for Functional Assessment.

(Patient with Normal Right Ventriculogram Suspected of Having ARVD.)

The second case is a young male with palpitations. A clinical workup revealed episodes of left bundle branch block-type ventricular tachycardia as well as frequent premature ventricular contractions. A family history of sudden cardiac death of unknown etiology was reported. MRI was attempted but had to be terminated due to severe claustrophobia. A cardiac gated CT was requested to interrogate for possible presence of major or minor criteria of ARVD. Specifically, the presence of RV fatty infiltration and RV functional abnormalities (dilatation, dyskinesia, RV aneurysms) had to be excluded. After a timing bolus acquisition, a triphasic injection protocol was selected for the CTA acquisition to allow for homogeneous opacification of the right atrium and ventricle.

The rationale of the injection protocol is to have optimal arterial opacification (first phase) and, instead of a washed out heart, to have contrast within the right heart. The reduced rate of the second phase allows mixing of the slower injected contrast with a relatively larger amount of non-enhanced venous blood return from the head and the contralateral upper extremity, thus avoiding excessive mixing artifact in the right heart. The heart rate during this acquisition was 85 BPM resulting in motion artifact in the coronary arteries.

This case illustrates optimal enhancement of the left cardiac chambers and the right atrium and ventricles. Functional images allowed for assessment of right ventricular function and ejection fraction.

Equipment/Contrast	
CT Scanner	Siemens Sensation-64
Contrast Power Injector	E-Z-EM EmpowerCTA
Contrast	ISOVUE 370

Injection Protocol: Triphasic Injection

Phase	Flow Rate	Volume	Time
Test bolus	5 mL/sec	20 mL	4 sec
Contrast Phase 1	5 mL/sec	60 mL	12 sec
Contrast Phase 2	2 mL/sec	20 mL	10 sec
Saline Phase 3	5 mL/sec	20 mL	4 sec

The functional images in this patient demonstrated normal RV dimensions and contractility, and absence of RV dyskinesia or aneurysms. No fatty infiltration of the right ventricular freewalls was identified.

In this patient, CTA with a triphasic injection protocol allowed for complete functional assessment of the right ventricle, despite contraindication to MRI.

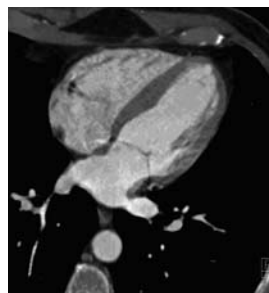


Figure 1. Coronary CTA acquired with triphasic injection protocol demonstrates good opacification of the left and right ventricles and both atria with no significant mixing artifact in the right heart.

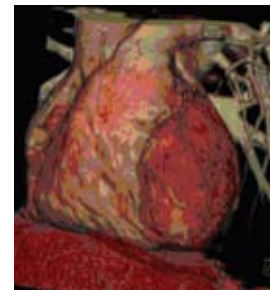
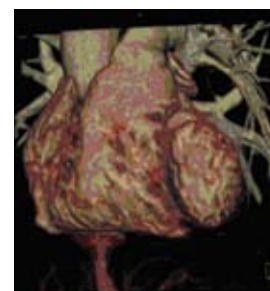
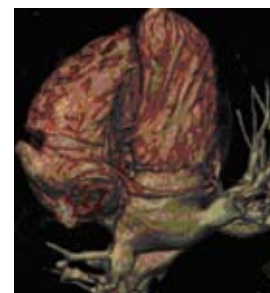


Figure 2. The color illustrations below demonstrate frames from the CT right ventriculogram which allow appreciation of fine anatomic detail.





Visualize a healthier world

E-Z-EM, INC.

Global Headquarters

1111 Marcus Avenue, Suite LL26
Lake Success, NY 11042 USA
Phone: 516-333-8230
Toll Free: 1-800-544-4624 (US only)
Fax: 516-302-2919
www.ezem.com

E-Z-EM Ltd.

International Office

Avonbury Business Park
Howes Lane, Bicester
OX26 2UA, United Kingdom
Orderline: 0800 18 17 33 (UK only)
Phone: +44 (0) 1869 366900
Fax: +44 (0) 1869 366999

Manufactured by: E-Z-EM, Inc., Lake Success, NY 11042 USA