

Anteriorly displaced right coronary artery in acute myocardial infarction: what should every cardiologist know

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Abstract

Anteriorly displaced right coronary artery (RCA) and anomalous origin RCAs occur in $\approx 1\%$ and 0.1% of adult patients, respectively, and are the leading cause of incomplete coronary angiography and prolonged procedure times. We present a case in which anteriorly displaced RCA occlusion resulted in an acute inferior–posterior–right ventricular myocardial infarction complicated by complete atrioventricular block and hypotension. Failure to image the RCA resulted in considerable delay in reperfusion time with fibrinolysis. The authors discuss the most frequent anatomic locations of ectopic RCAs and suggest an algorithm to be employed when an ectopic RCA cannot be imaged with conventional diagnostic catheters. Contrary to popular belief, the search for an ectopic RCA has $<90^\circ$ boundaries limited to the anterior third of the right sinus and anterior half of the left sinus. © 2011 Elsevier Inc. All rights reserved.

Keywords:

Right coronary artery; Anomalous coronary artery; Coronary angiography; Echocardiography; Computed tomography; Myocardial infarction

1. Case presentation

A 47-year-old African-American female reported sudden onset of chest pain occurring 3 h after cocaine use and 60 min prior to her hospital admission. Chest pain was associated with diaphoresis and presyncope. The patient was a cigarette smoker and occasional cocaine user and was not known to suffer from any medical problem or receive any medical therapy. The EMS transmitted EKG via LifeNet (Fig. 1) which revealed acute inferior–posterior wall myocardial infarction as well as probable right ventricular

infarction (ST elevation in V_1 lead). In transit to the university hospital, the patient received aspirin 325 mg and 500 ml normal saline intravenously for hypotension. In the emergency department, heparin bolus (4000 U intravenously) was given and the patient was transferred to the cardiac catheterization laboratory (CCL).

On admission, the patient appeared to be in distress and reported severe chest pain (8 of 10). Her blood pressure was 99/51, heart rate was 48 (regular), respiratory rate was 25, and pulse oxymetry was 92% on room air. Cardiac exam and lung examination results were unremarkable with the exception of jugular venous distention. The admission laboratory blood work was all within normal range. The patient was transferred to the CCL for coronary angiography (CA) and percutaneous coronary intervention. The left coronary artery was not affected by significant obstructive coronary disease (Fig. 2). The right coronary artery (RCA) could not be imaged. Ventriculography and aortography

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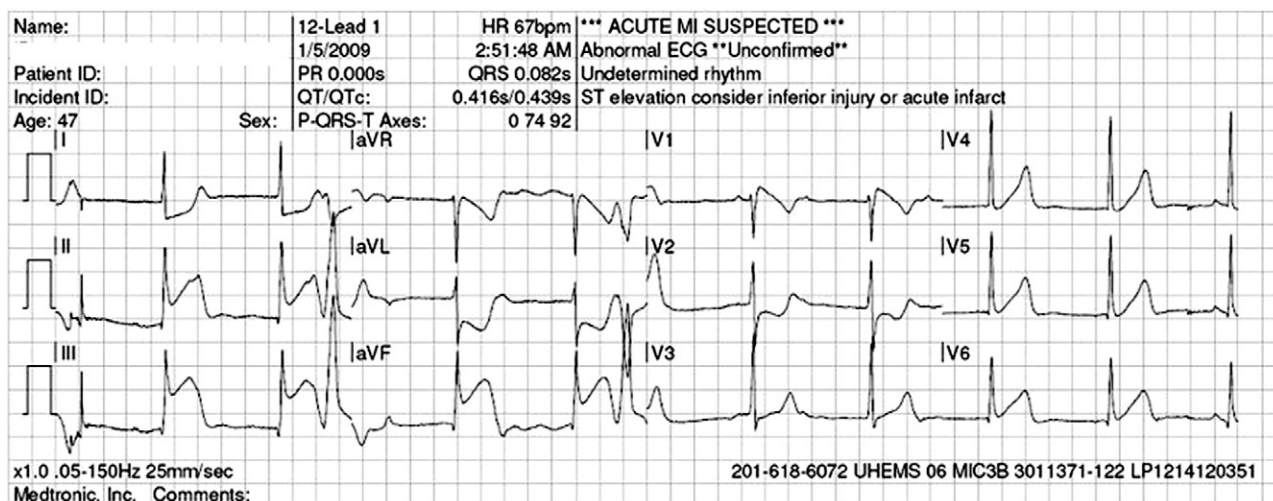


Fig. 1. Electrocardiogram transmitted by the mobile intensive care unit, showing acute inferoposterior myocardial infarction.

(Fig. 3) failed to image or disclose the location of the RCA. After numerous attempts using multiple catheter shapes and sizes, the RCA could not be visualized. During these attempts, the patient developed complete atrioventricular block and severe hypotension which required temporary transvenous pacing and dopamine administration. CT angiogram was done emergently (using a 16-slice CT while employing a dissection protocol). The CT angiogram demonstrated normal aorta and failed to disclose the orifice of the ectopic RCA. After a failed second attempt to image selectively the RCA, tissue plasminogen activator was administered (225 min from emergency department arrival) with subsequent evidence of successful reperfusion (80% ST elevation and pain resolution 90 min after fibrinolysis administration). On the day after admission, creatine phosphokinase and troponin I peaked at 8369 U/l and 227 ng/ml, respectively. Transthoracic echocardiogram showed

right ventricular dilation with hypokinesis as well as akinetic inferoposterior wall. Subsequently, transesophageal echocardiogram demonstrated that the RCA was originating from the anterior one third of the right cusp (Fig. 4). In addition, color flow Doppler demonstrated normal RCA flow: flow velocity during systole exceeding flow during diastole (Fig. 5). The RCA course was delineated: from left superior to right inferior region. Equipped with this information, we used an Amplatz Left 4-French catheter to successfully catheterize and image the anteriorly displaced RCA (Fig. 6).

2. Discussion

Ectopic RCAs are the most frequent cause of incomplete CA and prolonged procedure and fluoroscopy time

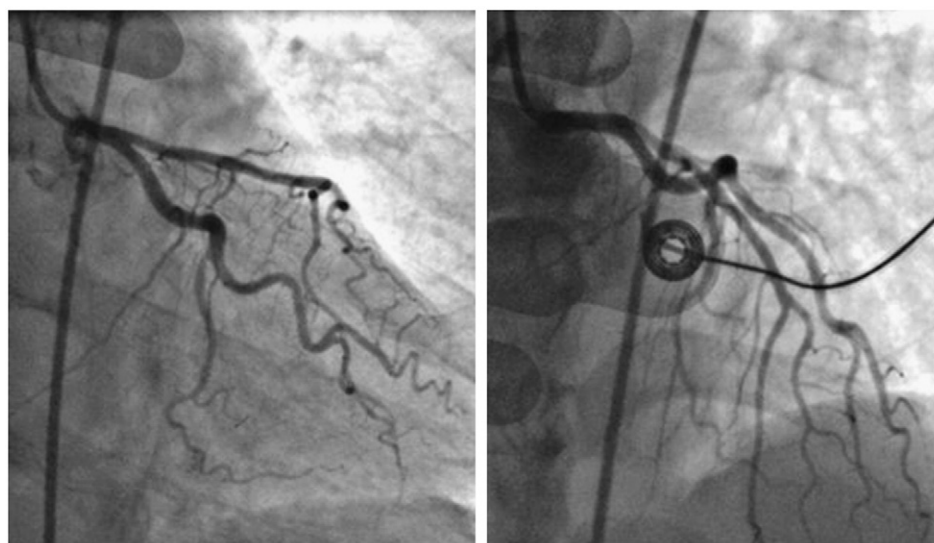


Fig. 2. Images of the left coronary system demonstrating no significant coronary artery disease and absence of collateral flow to the right coronary artery.



Fig. 3. Ventriculography and aortography do not disclose the location of the right coronary artery.

during CA and PCI [1]. Since there are no universally accepted definitions for ectopic RCAs, there are considerable variations in the reported frequency of this condition

ranging between 0.04% [2] and 0.46% [3]. However, most reports do not include the anteriorly displaced RCA as a coronary anomaly.

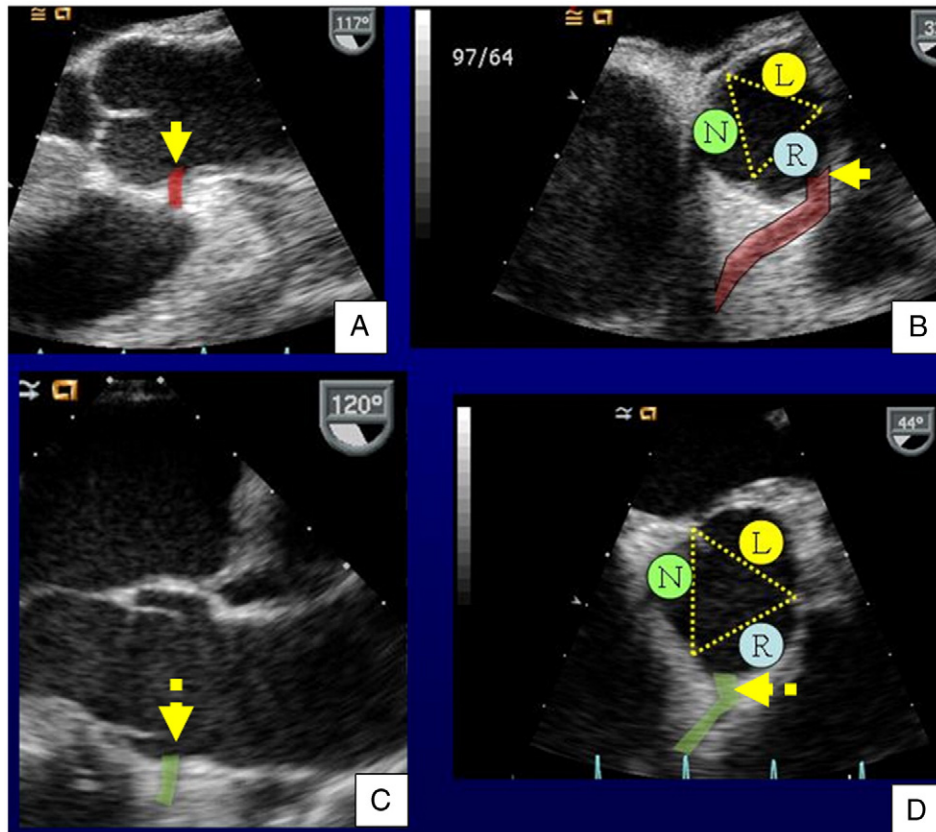


Fig. 4. Transesophageal echocardiography images showing the RCA orifice in the patient with anteriorly displaced RCA in long axis (A) and short axis (B), as opposed to a normal RCA (C and D, respectively).

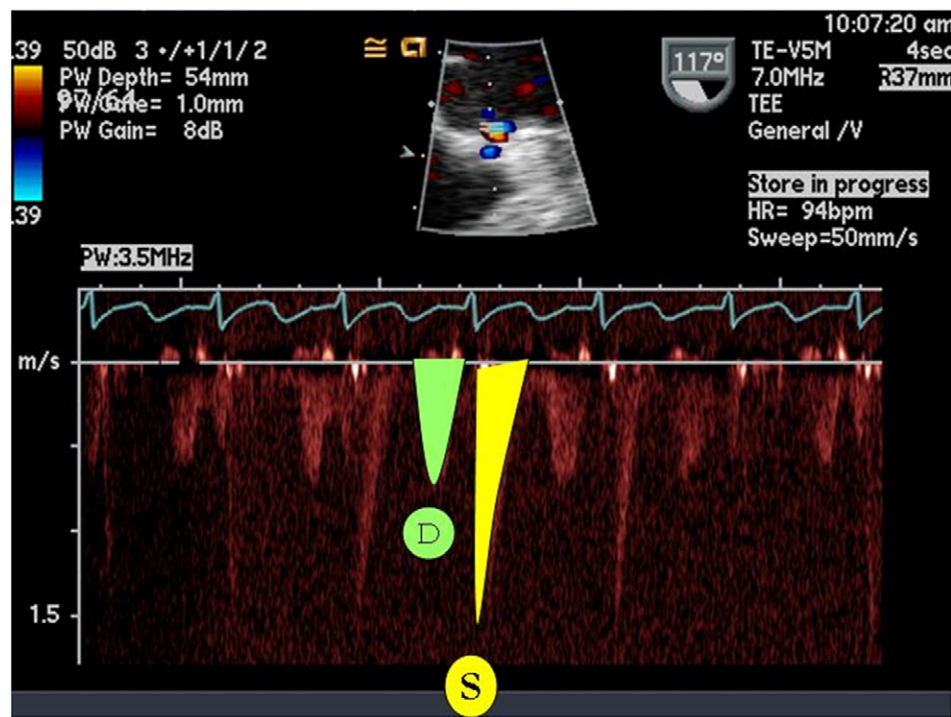


Fig. 5. Transesophageal echocardiography confirms Doppler flow within the patent anteriorly displaced RCA (note the systolic flow velocity exceeding the diastolic flow velocity).

2.1. Location of ectopic RCAs

Villalonga [4] reported that former studies by Banchi [5] and Hackensellner [6] suggest that RCAs originate from the posterior third, middle third, and anterior third of the right sinus in 40%, 59%, and 1%, respectively (Fig. 7). Since

99% of RCAs originate from the posterior two thirds of the right sinus, for the purpose of our discussion, ectopic RCAs will be defined as RCAs originating outside that zone. Pathology series [7] reveal that high takeoff RCAs [defined as RCAs originating >10 mm superior to the sinotubular junction (STJ)] are encountered less frequently

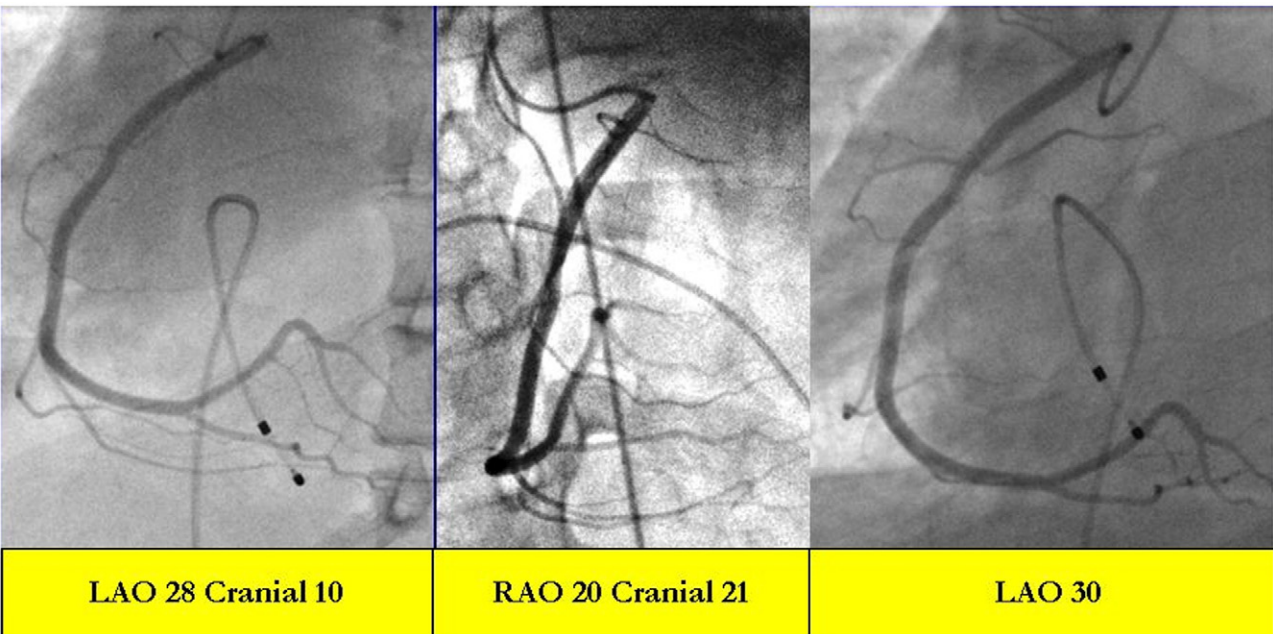


Fig. 6. Three views of the anteriorly displaced RCA imaged by a 4-French Amplatz Left 1 diagnostic catheter.

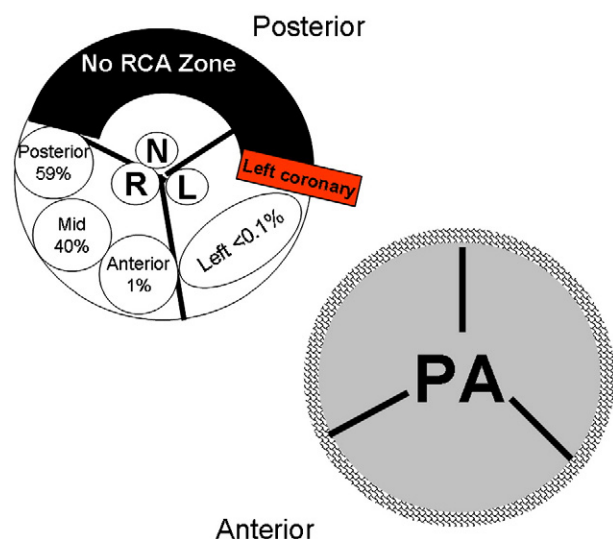


Fig. 7. The frequency of locations of RCA within the right (R), left (L), and noncoronary (N) or posterior sinus. (Note that RCAs do not originate from the noncoronary cusp or posterior to the left main artery.)

(14%) than high takeoff left coronaries (36%). High takeoff RCAs usually do not present an imaging challenge during CA since they can be imaged subselectively by a right sinus injection and selectively by conventional right diagnostic catheters (Judkins Right 3–4, Amplatz Right 1–2, or Williams curves).

The most common location of ectopic RCAs is the anterior one third of the right (first) sinus [1] also called “anteriorly displaced RCA.” To selectively image ectopic RCAs in this location, the optimal catheter is Amplatz Left 1 [8]. In the 30° right anterior oblique projection, the catheter should be pointing anterior (to the right).

The second most common site of ectopic RCAs is the anterior one half of the left (second) sinus and accounts for 0.1% [9] to 0.46% [3] of RCAs. These ectopic RCAs can be frequently subselectively imaged by an injection into the left sinus and may originate anterior, superior, adjacent, or directly from the left main coronary, but practically never posterior to the left main coronary [1]. To add to the complexity of selective imaging of these anomalous vessels, frequently these RCAs have a high takeoff [8–10] (1–4 cm above STJ) and most of these have an extreme caudal orientation and almost always run a course between the aorta and the pulmonary artery (occasionally within the aortic wall tunica media) [11,12] until the artery assumes a conventional RCA course along the right atrioventricular groove. During this initial segment, the ectopic RCA may assume an eccentric slit-like appearance that could be mistaken as an atherosclerotic lesion [13,14] and may subject patients to ischemia and arrhythmic death. A long list of diagnostic and interventional guiding catheters can be used to image these arteries including Multipurpose 1–2, Extra Back-Up Left, VODA, and Amplatz Left series.

The cardiologist should know that ectopic RCAs practically never originate from the posterior (noncoronary) sinus or from the posterior one half of the left coronary sinus (posterior to the left main artery). Although some angiographic reports [15,16] suggested that RCAs can originate from the noncoronary cusp, these observations were never substantiated by solid pathology, CT angiograms [17], MRI [18], echocardiography [19], or transesophageal echocardiography [20] series.

2.2. Suggested algorithm when seeking for an ectopic RCA

Algorithms for imaging selectively an ectopic RCA have been suggested by Jim et al. [1]. We suggest a somewhat different four-step algorithm:

- (1) After failing to image the RCA by conventional RCA diagnostic catheters, perform a right sinus injection at left anterior oblique 30–40° projection (or biplane imaging when available) via a diagnostic Judkins Right 4 catheter. This injection will usually delineate RCAs originating from the posterior two thirds of the right sinus and will provide information regarding takeoff and orientation of these RCAs. If RCA cannot be visualized at all progress to Stage 2.
- (2) Use an Amplatz Left 1 and in right anterior oblique projection 30–40° with the catheter pointing anterior attempt to engage the RCA originating from the anterior one third of the right coronary sinus (also known as anteriorly displaced RCAs). If subselective injections failed to image the RCA at this location, it is likely that the RCA is originating from the anterior half of the left sinus, hence progress to Stage 3.
- (3) Using the same Amplatz Left 1 or other left diagnostic catheters in left anterior oblique 30–40° projection, inject subselectively into the left coronary sinus adjacent but anterior to the left coronary ostium. If you failed to see the RCA, you can repeat the injection above the left coronary ostium to image ectopic RCAs with higher left sinus takeoff.
- (4) If all failed, obtain an aortogram in left anterior oblique 40° projection (or biplane if available).

3. Conclusion

Ectopic RCAs pose a serious problem for the cardiologists and can result in excessive procedure and fluoroscopy time, high contrast load, and incomplete or inconclusive studies. The cardiologist should be familiar with RCA variants or ectopic RCA anatomy and adopt an effective algorithm to image these vessels selectively. Finally, in acute myocardial infarction related to an ectopic RCA, which for some reason cannot be selectively visualized, fibrinolysis is still a valid option.

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