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Dominant Interarterial Ramus in a Right-Sinus Single Coronary Artery: A Case Report on Deviation from Lipton's Classic R-III Variant on CT- CAG

Case Report

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Abstract

Single coronary artery (SCA) is a rare congenital coronary anomaly in which all three major coronary arteries arise from a single aortic sinus. We present a unique case of a 59-year-old female who underwent coronary computed tomography angiography (CTA) for evaluation of new-onset ventricular ectopics and epigastric discomfort. Imaging revealed a solitary coronary artery arising from the right sinus of Valsalva, giving rise to the right coronary artery (RCA), left anterior descending artery (LAD), left circumflex artery (LCx), and a prominent ramus intermedius. The LAD had a benign prepulmonic course, while the LCx followed a retroaortic route. Notably, the ramus intermedius coursed between the aorta and pulmonary artery (interarterial), and was the dominant vessel supplying the lateral wall of the left ventricle due to diminutive obtuse marginal branches. This configuration is a previously undescribed variant diverging from the classic R-III Lipton classification and represents a potentially malignant anomaly. Recognition of such atypical and hemodynamically significant variants is crucial for clinical risk stratification and interventional planning.

Keywords: Single Coronary Artery; Lipton Classification Variant; Interarterial Ramus; Coronary CT Angiography; Malignant Coronary Anomaly; R-III Deviation

Abbreviations

SCA – single coronary artery; R – right sinus of Valsalva; L – left sinus of Valsalva; RCA – right coronary artery; LAD – left anterior descending artery; LCx – left circumflex artery; LMCA – left main coronary artery; RI – ramus intermedius; A – prepulmonic course (anterior to pulmonary artery); B – interarterial course (between aorta and pulmonary artery); P – retroaortic course (posterior to aorta).

Introduction

Coronary artery anomalies (CAAs) are rare congenital abnormalities, occurring in less than 1% of the population undergoing coronary angiography [1]. Among these, single coronary artery (SCA) anomalies—where one coronary artery arises from a solitary ostium—are particularly uncommon, with a reported prevalence between 0.024% and 0.066% [2].

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Lipton et al. classified SCAs based on the sinus of origin (right or left) and the anatomical distribution pattern of the coronary branches [3]. This system is widely used to describe and stratify the potential clinical relevance of various SCA subtypes.

The clinical significance of SCAs depends largely on the course the vessels take. Benign variants may be asymptomatic and discovered incidentally, whereas malignant variants, particularly those with an interarterial course, may pose a risk for myocardial ischemia or sudden cardiac death [4]. Our case presents an atypical configuration with a malignant interarterial course of the ramus intermedius, a variation that has not been explicitly described in the Lipton classification system.

Case Report

A 59-year-old female with a history of new-onset ventriucular ectopics and epigastric discomfort was referred for coronary CTA. The scan was performed using ECG-gated multidetector CT after administration of 100 ml of non-ionic contrast (Ultravist).

The study revealed a single coronary artery arising from the right sinus of Valsalva, bifurcating into four major branches: RCA, LAD, LCx, and a ramus intermedius.

- The LAD took a benign prepulmonic course anterior to the right ventricular outflow tract and terminated near the apex.
- The LCx had a retroaortic course, passing posterior to the aortic root and anterior to the atria, giving rise to narrow-caliber obtuse marginal branches.
- The ramus intermedius, unusually dominant (obtuse marginal arteries and diagonal branches being very small in calibre), coursed between the aorta and pulmonary artery, representing an interarterial (malignant) course. It supplied the lateral wall of the left ventricle with no significant contribution from other lateral branches.

No coronary ostia were visualized in the left or non-coronary sinuses. The coronary arteries showed no significant atherosclerosis, and calcium score was zero.

Discussion

SCA anomalies with origin from the right sinus are less common than those from the left. The R-III subtype, as seen in this case, is among the rarest configurations described in Lipton's classification, where all major coronary arteries arise from the right sinus and follow separate anomalous courses [3,5].

Lipton's classification system categorizes SCAs using a combination of origin site ("R" for right sinus, "L" for left), and further subclassifies them into three types:

- Type I: A single coronary artery follows the course of either a normal right or left coronary artery.
- Type II: The single coronary artery bifurcates into right and left systems.
- Type III: The left anterior descending (LAD) and left circumflex (LCx) arteries arise separately from the proximal right coronary artery (RCA), as in our case.

Each type is further classified based on the anatomic course taken by the arteries: "A" for anterior to the pulmonary artery (prepulmonic), "B" for between the aorta and pulmonary artery (interarterial), and "P" for posterior to the aorta (retroaortic).

In our case, the LAD demonstrated a benign prepulmonic course and the LCx had a retroaortic course. However, the ramus intermedius presented a critical deviation—coursing interarterially in a hemodynamically dominant fashion, with narrow obtuse marginals failing to compensate. This raises concern for compression between the great vessels, especially under stress conditions, posing a potential risk for myocardial ischemia or sudden cardiac death [4,6].

To date, a dominant ramus intermedius with a malignant interarterial course in the setting of a single coronary artery has

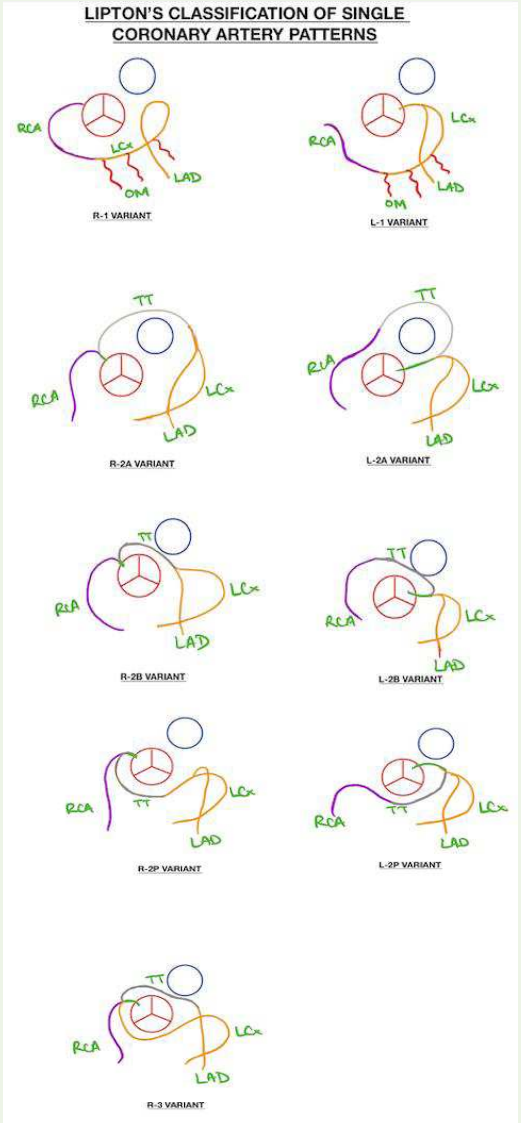

Figure 1: Schematic diagram representing Lipton's classification on axial CT angiography section at the level aortic root and pulmonary trunk. Abbreviations: RCA- right coronary artery, LAD - left anterior descending, LCx- left circumflex artery, OM - obtuse marginal, TT- transverse trunk.

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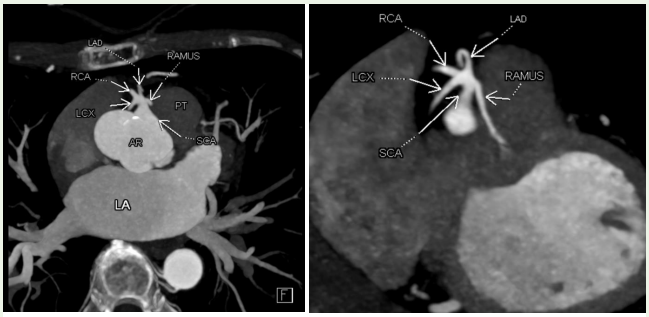
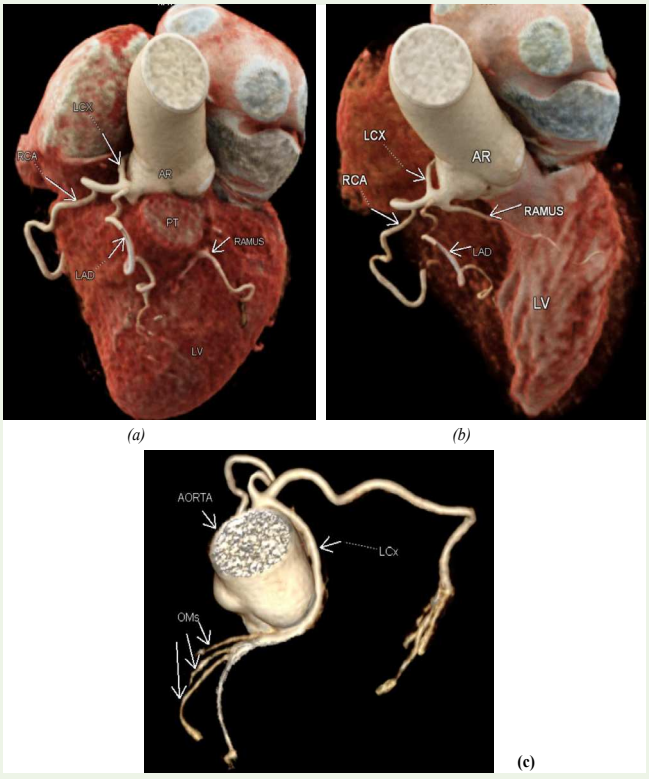


(a) (b)

Figure 2: (a) and (b) show oblique reformatted CT angiographic image showing the single coronary artery (SCA) arising from the right coronary sinus. The vessel divides into the right coronary artery (RCA), left anterior descending artery (LAD), left circumflex artery (LCx), and a prominent ramus intermedius (RI). No ostia are seen in the left coronary sinus.

Abbreviations: SCA – single coronary artery; RCA – right coronary artery; LAD – left anterior descending artery; LCx – left circumflex artery; AR- Aortic Root; LA- left atrium; PT - pulmonary trunk



(a) (b) (c)

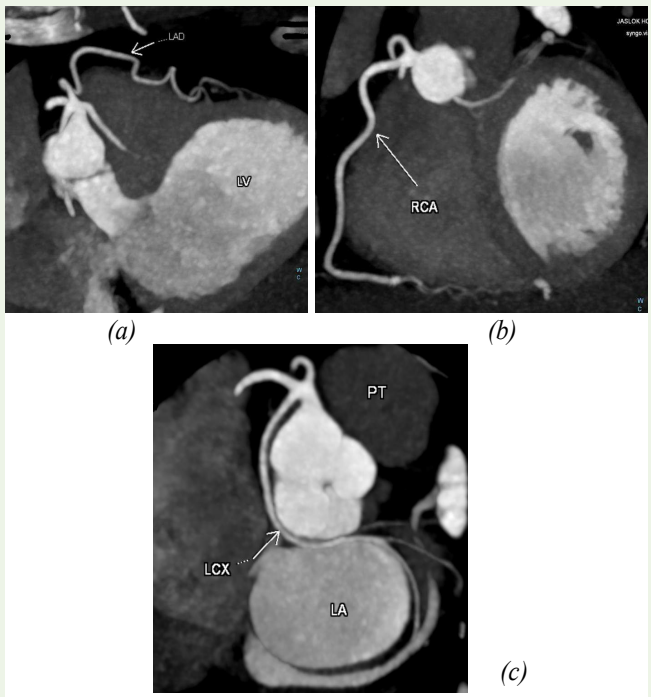
Figure 3: (a) shows a 3D volume-rendered image (VR) showing the origin of all four vessels from a single trunk at the right coronary sinus. The dominant RI branch is prominently visualized heading toward the anterolateral left ventricular wall. (b) reveals the same findings after subtraction of the right ventricle and it's outflow tract. (c) Image highlighting the Obtuse Marginal (OM) arteries arising from the LCx , which are small in caliber compared to the prominent ramus intermedus (RI).

Abbreviations: VR – volume rendered; RI – ramus intermedius; RCA – right coronary artery; LAD – left anterior descending artery; LCx – left circumflex artery; AR- Aortic Root; LA- left atrium; PT - pulmonary trunk; OM- Ontuse Marginal Artery

(a) **(b)**

Figure 4: (a) Image highlighting the interarterial course of the ramus intermedius (RI) coursing between the aorta and pulmonary artery, raising concern for malignant compression risk. (b) Image highlights the complete course of of RI towards the diagonal territory.

Abbreviations: RI – ramus intermedius; PT - pulmonary trunk; AR- aortic root; LA- left atrium; LV- left veentricle; RV- right ventricle



(a) (b) (c)

Figure 5: This figure outlines the reformatted oblique CT angiographic images showing the course of the other major coronary vessels, namely (a) LAD (b) RCA (c) Lcx

Abbreviations: RCA – right coronary artery; LAD – left anterior descending artery; LCx – left circumflex artery; LV- left ventricle; PT- pulmonary trunk; LA- left atrium.

not been clearly documented in literature. A report by Paolillo et al. described a ramus artery with an intraseptal course, potentially subject to systolic compression, but without a truly interarterial trajectory [8]. Another reported case from Radiopaedia involved a trifurcating left main artery with interarterial left main and ramus courses; however, that anatomy did not arise from a single coronary

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Table 1: Summary of Lipton classification of single coronary artery (SCA) anomalies and comparison with previously reported anomalous coronary patterns.

Case / Type	Origin	Branching Pattern	Course	Clinical Significance
Lipton Type I	Right (R) or Left (L)	Single artery follows RCA or LCA pathway	Normal course	Benign
Lipton Type II	Right (R) or Left (L)	Bifurcates into RCA and LCA from a single ostium	LAD: A/P/B; LCx: A/P/B (varies by subtype)	May be benign or malignant depending on course
Lipton Type III	Right (R)	Separate origins of RCA, LAD, LCx from single trunk	LAD: typically, prepulmonic; LCx: typically, retroaortic	Rare; some courses benign, others potentially malignant
Present Case (Ours)	Right sinus	RCA, LAD, LCx, and dominant ramus from common trunk	LAD: prepulmonic (benign); LCx: retroaortic; Ramus: interarterial (malignant)	Novel variation; first reported R-III-like pattern with dominant malignant ramus

ostium [9]. This highlights the uniqueness of our case as the first to combine a single right sinus origin, dominant interarterial ramus, and classic R-III branching anatomy with significant lateral wall supply.

Conclusion

We report a novel variant of a single coronary artery arising from the right sinus of Valsalva with a malignant interarterial ramus intermedius, a prepulmonic LAD, and retroaortic LCx. This deviates from the classic R-III subtype of Lipton classification and warrants attention due to the hemodynamic dominance and malignant course of the ramus. Recognition and documentation of such variations are essential for clinical decision-making and procedural safety.

Table 1: Summary of Lipton classification of single coronary artery (SCA) anomalies and comparison with previously reported anomalous coronary patterns.

The table outlines key features of each Lipton subtype (Types I–III), highlighting differences in origin, branching, course of the coronary arteries and compares it to our case.

Our case demonstrates a novel variation with a dominant ramus intermedius arising from a right sinus SCA and taking a malignant interarterial course, which has not been previously documented in literature.

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