



## Intra-atrial course of right coronary artery: A case report

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### Abstract

#### BACKGROUND

Intra-atrial right coronary artery (RCA) is a rare and generally asymptomatic anomaly of development of the coronary arteries. This malformation could potentially expose the patient to a catastrophic outcome in the case of injury during interventional or surgical procedures. Currently, only a few case reports and no systematic reviews are available in the literature.

#### CASE SUMMARY

We report the case of a 54-year-old man with atypical chest pain who underwent multi-detector computed tomography angiography (MDCTA). The exam revealed no significant coronary artery stenoses; however, an intra-atrial course of mid RCA was evident. Medical therapy was administered, and the patient was discharged to home without undergoing a conventional angiography. Previously reported autoptic and clinical cases were retrieved from the PubMed literature database to compare the clinicopathological features of this case.

#### CONCLUSION

MDCTA depicted the abnormal course of the coronary artery in this patient as an intra-atrial course of the mid RCA. Finding this abnormality was crucial to avoid an inadvertent injury during interventional or surgical procedures.

**Key Words:** Coronary artery anomaly; Anomalous course of right coronary artery; Intra-atrial right coronary artery; Intracavitary right coronary artery; Multi-detector computed tomography angiography; Case report

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**Core Tip:** We present a rare case of an intra-atrial course of the mid right coronary artery (commonly referred to as right coronary artery) detected by multi-detector computed tomography angiography (MDCTA). We performed a systematic review of the few cases in the literature. Since this anomaly could potentially expose the patient to catastrophic outcome in case of injury during interventional or surgical procedures, its recognition *via* MDCTA is crucial before such interventions.

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## INTRODUCTION

Intra-atrial or intra-cavitary course of the right coronary artery (RCA) is defined as a segment of the RCA that courses through the right atrial (RA) chamber[1,2]. It is a relatively rare vascular anomaly, with a reported incidence of 0.09%-0.1%[1,2].

Historically, this anomaly of development was most often identified by accident, during coronary surgery or autopsy, due to its benign outcome; however, in the era of multi-detector computed tomography angiography (MDCTA), it is now detected more frequently, and its incidence rate has risen to 1.8%[1]. From a radiological point of view, it was defined as a segment of RCA entirely surrounded by intra-atrial contrast in all phases of the cardiac cycle, unlike the myocardial bridge, in which a segment of the coronary artery appears as entirely surrounded by myocardial muscle[1,2]. Its recognition is very important before cardiac surgery or endocavitary procedures (*i.e.* ablation for arrhythmias, catheterization of the RA, and pacemaker implantation) since it carries a concerning potential for injury to the intra-atrial RCA, which could have a catastrophic outcome[1].

Herein, we report the case of a patient with an anomalous course of the RCA through the RA which was identified using MDCTA. Furthermore, to the best of our knowledge, we provide, for the first time, a discussion based on a review of all cases of intra-atrial course of RCA in the literature. The review was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the University of Padua.

## CASE PRESENTATION

### Chief complaints

A 54-year-old Caucasian male with moderate cardiovascular risk factors (*i.e.*, obesity, hyperlipidemia, and hypertension) presented to the cardiologic clinic with atypical angina presenting without dyspnea.

### History of present illness

The patient reported that the symptoms had started 2 h before presentation, describing atypical chest pain without dyspnea.

### History of past illness

The past history of the patient was unremarkable.

### Personal and family history

The patient denied any personal history relevant to atypical angina, dyspnea, or other cardiovascular symptoms and any family history of cardiovascular disease.

### Physical examination

On physical examination, the significant vital signs were as follows: body mass index of 28.7 kg/m<sup>2</sup>; heart rate at regular pulse of 80 beats per min; and blood pressure of 163/92 mmHg. Dyspnea, heart murmurs, and other signs of heart failure were absent.

### Laboratory examination

Levels of myocardial injury enzymes (*i.e.*, troponin T and creatine kinase) were normal. Electrocardiography demonstrated a sinus rhythm of 77 beats per min and absence of ST depression with minimal alterations in lateral repolarization.

## Imaging examination

The patient underwent MDCTA (Aquilion ONE; Toshiba Medical Systems, Otawara, Japan) using the following scan parameters: prospective protocol; gantry rotation time of 350 ms; 512 × 512 matrix; slice thickness of 0.5 mm with 0.25 mm increments using kernel FC03; automatic exposure control (SURE bExposure 3D; Toshiba Medical Systems) (SD 110 for contrast-enhanced images); and iterative reconstruction.

An intravenous contrast (60 mL Iomeron® 400 mg iodine/mL; Bracco Imaging Italy s.r.l., Milan, Italy) was administered at 5 mL/s flow. Heart rate was set between 50 and 60 beats per min with intravenous administration of metoprolol. The data were transferred to an external workstation (Vitrea2 FX version 6.3; Vital Images, Plymouth, MN, United States) providing multiplanar reformation (commonly referred to as MPR) and volume rendering technique (commonly referred to as VRT).

From the scans, mild coronary calcification (Agatston calcium score of 34) of the left anterior descending (LAD) coronary artery, without significant stenoses (> 70%) of all segments, was detected. Additionally, an abnormal course of the mid RCA was identified. As demonstrated by axial images and CT multiplanar reconstruction, the origin and the proximal tract of the RCA were normal, with an epicardial course in the right atrio-ventricular groove; however, the artery penetrated the anterior RA wall and then exhibited an intracavitary course of 25 mm (Figure 1). After the exit from RA, the RCA passed normally in the atrio-ventricular groove and then continued normally at the level of the diaphragmatic crux.

## FINAL DIAGNOSIS

Considering the patient's medical history along with the MDCTA imaging findings, the final diagnosis was an intra-atrial course of the mid RCA without significant coronary atherosclerosis.

## TREATMENT

The patient responded well to standard medical therapy (*i.e.*, rosuvastatin, administered at 5 mg per day) and was discharged home on postoperative day 2 without having to undergo a conventional angiography study.

## OUTCOME AND FOLLOW-UP

At the last follow-up (5 mo postoperatively), the patient was still alive.

## DISCUSSION

RCA anomalies are rare and abnormal courses of the RCA are even more rare, with an incidence of 0.1% [2]. In the literature, an intra-atrial course of the RCA was reported only in 9 autopsic cases [3,4] and in about 80 clinical cases [1,2,5-26] (Table 1). Most clinical cases were case reports, but a few case series were reported [1,2,5,9,10,16,21].

An intra-atrial course of RCA was first described in 1975 by McAlpine [27]. The prevalence of this variant was initially reported to be between 0.09% and 0.1% [5-7], but these rates probably represented underestimations because the conventional angiographic luminographic 2D assessment may not be able to recognize this abnormal variant. The most recent studies – involving cases that are being diagnosed by the new advanced imaging techniques – have reported a prevalence of 1.3% [2] and 1.8% [4]; certainly, the increasing use of MDCTA of the coronary arteries will lead to an even greater increase in identification of this anomaly [8].

Reportedly, the segments of the RCA most frequently involving an intra-atrial course were segments 3 (47%) and 2 (40%) [9], with mean length ranging from 14 mm to 53 mm [9]. In our perusal of the literature, the most frequent intra-atrial segment of the RCA reported was the mid segment (Table 1), with a length of intra-atrial RCA ranging from 13.2 mm [10] to 55 mm [5]. Rarely, the intra-atrial course of the RCA involved segments 1 and 4 (13%) [9] or has lengths shorter (as low as 13 mm) or longer (up to 55 mm) [10-12].

In our review of the literature, most cases were female, and the patient's ages ranged from 45 years [20] to 78 years [13]. In none of the cases was there presence of significant coronary artery stenoses nor were mild atherosclerotic plaques indicated [9]. A possible explanation could be the absence of mechanical stress on the segment of the coronary artery when it coursed intra-atrially or intra-myocardially rather than in the epicardial fat, although this conclusion is not definitive [9].

Table 1 Literature summary of intra-atrial course of the right coronary artery

Ref.	Patients, n	Type	Sex	Age in yr	Risk factors	Symptoms	Imaging	Segment of RCA	Intra-atrial course length in mm	Stenosis, %	Outcome
Kolodziej <i>et al</i> [3], 1994	3	Autoptic series	UNK	UNK	UNK	UNK	Postmortem examination	Mid	15; 20; 30	No	Mortem
Rosamond <i>et al</i> [14], 2007	1	Case report	M	54	NR	Palpitation, atrial fibrillation	MDCTA 64	Distal	35	No	No atrial fibrillation
Scheffel <i>et al</i> [11], 2007	1	Case report	F	77	Hypertension, hyperlipidemia, family history	Atypical chest pain	MDCTA	Mid	55	No	NR
Zalamea <i>et al</i> [5], 2009	2	Series	F; F	70; 54	Atrial fibrillation; Smoker	Dyspnea on exertionChest pain, nausea, diaphoresis	MDCTA	Mid-distal; Mid-distal	40-50; 55	No; No	No ablation; NR
Andrade <i>et al</i> [6], 2010	1	Case report	M	46	Strong family history	No	MDCTA	Mid	25	No	NR
Lee <i>et al</i> [8], 2010	1	Case report	F	57	Hypertension, hyperlipidemia	Atypical chest pain	MDCTA	Mid	38	No	Discharged
Renapurkar <i>et al</i> [12], 2010	1	Case report	F	49	Family history	Atypical chest pain	MDCTA 64 DS	Mid	10	No	NR
Chou <i>et al</i> [19], 2011	1	Case report	M	56	Diabetes, hypertension	Chest tightness	MDCTA	PL	NS	No	Symptoms persistence
Christopher and Duraikannu[7], 2011	1	Case report	F	48	No	Chest pain, dyspnea, palpitation	MDCTA	Mid	15	No	NR
Bansal <i>et al</i> [10], 2011	2	Series	NS	NS	NS	NS	MDCTA	Segment 3; Segment 2	13.2; 15.6	NS	NS
Zeina[17], 2011	1	Case report	M	59	Multiple	Chest pain	MDCTA 64	Distal	40	No	NR
Waniewska <i>et al</i> [24], 2012	1	Case report	F	62	NR	Atrial flutter, atrial fibrillation, fainting, hypotension	MDCTA	Distal	50	No	RFA
Opolski <i>et al</i> [9], 2014	14	Series	M:F = 2:12	54 (mean)	Diabetes, hypertension, hyperlipidemia, smoker, family history	Atypical chest pain, stable angina pectoris, syncope, dyspnea, palpitations, arrhythmia	MDCTA	Segment 3 (47%); Segment 2 (40%); Segment 1 and 4 (13%)	29 (mean)	No	Conservative approach
Bunkiewicz <i>et al</i> [13], 2015	1	Case report	F	78	Hypertension, previous acute coronary syndrome	Not specific chest pain, low tolerance of physical effort, dry cough	MDCTA	Mid	20	No	UNK
Buckley <i>et al</i> [16],	17	Series	NS	NS	NS	NS	MDCTA	NS	NS	NS	NS

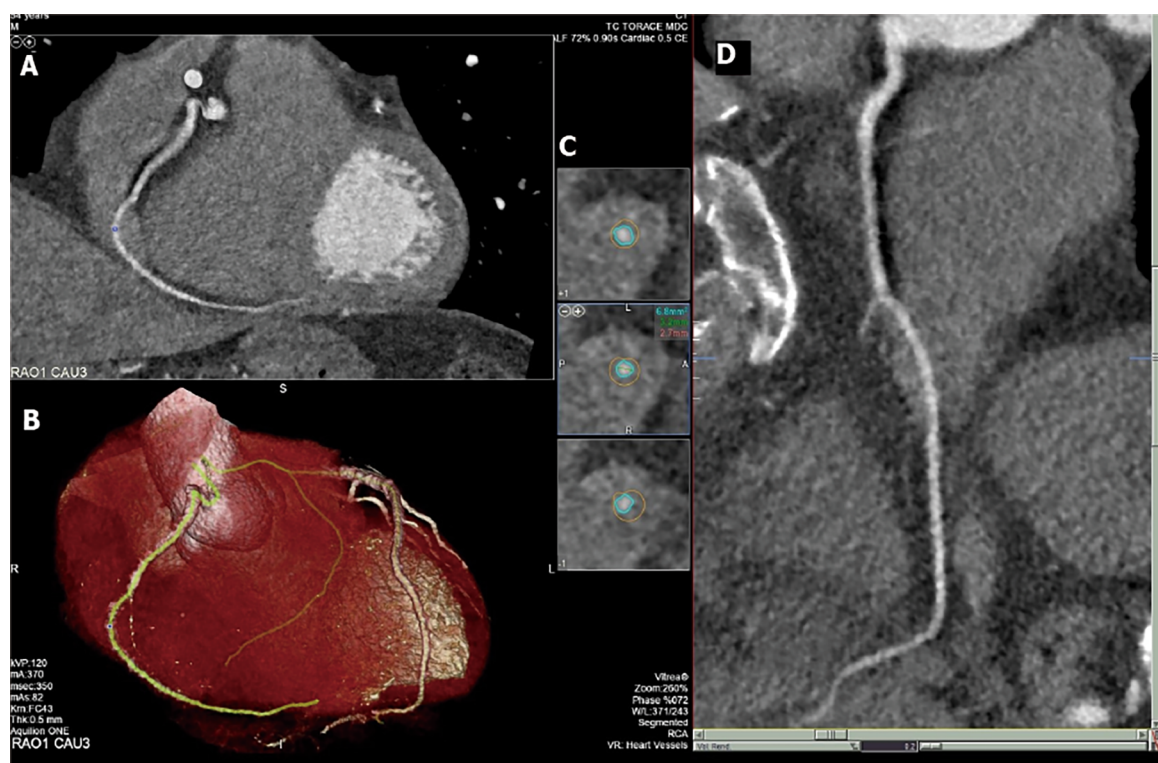
2017											
Krishnan <i>et al</i> [4], 2017	6	Autoptic series	M	69 (mean)	NS	UNK	Postmortem examination	Type I: Mid; Type II: Mid; Type III: Anterior branch	Type I: 22 (mean); Type II: 36; Type III: UNK	No	Mortem
Ganga <i>et al</i> [20], 2019	1	Case report	M	45	NR	Atypical chest pain	MDCTA	Mid	45	No	NR
Bouhuijzen <i>et al</i> [18], 2019	1	Case report	F	64	NR	Atypical chest pain	MDCTA	NS	40	No	
Hossain <i>et al</i> [2], 2019	7	Series	M:F = 71.4:28.6	67.3(mean)	Chest pain (25%), shortness of breath (33%)	Pre-TAVR	MDCTA	NS	33.4 (mean)	No	No coronary intervention
Mahmoud <i>et al</i> [22], 2020	1	Case report	F	61	NS	Chest pain	MDCTA	Mid	39	NS	NR
Junco-Vicente <i>et al</i> [21], 2020	3	Series	1M; 2F	NS	NS	Chest pain	MDCTA	Mid	27.7 (mean)	No	UNK
Marrone <i>et al</i> [26], 2020	1	Case report	F	48	Aortic valve disease	NR	MDCTA	Distal	49	No	NR
Ganga <i>et al</i> [1], 2021	21	Series	M:F = 1.3:1	53.7 (mean)	NR	NR	MDCTA	Mid (16/21); Distal (5/21)	14.85 (mean)	No	NR
Frey <i>et al</i> [23], 2022	1	Case report	M	55	Hypertension, hypercholesterolemia, smoker, obesity	Atypical angina, dyspnea	MDCTA	Mid (posterior)	40	No	Conservative approach
Borges <i>et al</i> [25], 2022	1	Case report	M	66	NS	Palpitation, tachycardia, dyspnea	MDCTA	Mid	30	No	NR
<b>Barbiero <i>et al</i></b>	1	Case report	M	54	Hypertension, hyperlipidemia, smoker	Atypical chest pain	MDCTA	Mid	25	No	Medical treatment

F: Female; M: Male; MDCTA: Multi-detector computed tomography angiography; NR: Not reported; NS: Not specified; PL: Posterior lateral; RFA: Radiofrequency ablation; TAVR: Transcatheter aortic valve replacement; UNK: Unknown; DS: Dual source.

Association between the intra-cavitary course of the RCA and other coronary anomalies have been described, such as with the intramuscular course of the LAD coronary artery or with the anomalous origin of the left circumflex (commonly known as LCX) coronary artery from the right aortic sinus[9]. Patients with intra-cavitary course of the RCA were usually asymptomatic, and its discovery was incidentally encountered during an MDCTA coronary study conducted for other reasons (*i.e.*, atypical chest pain, chest tightness, dyspnea, palpitation, atrial flutter or fibrillation, arrhythmia, fainting, hypotension, or syncope) (Table 1).

An intracavitary course of the RCA has a higher probability of iatrogenic damage than myocardial bridging because of the risk of direct injury at the abnormal vessel segment during surgical manipulation or endoatrial procedures (*i.e.*, ablation, catheterization, or electrode implantation). Therefore, although it is usually considered an asymptomatic variant, its early recognition is crucial to avoid vessel





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**Figure 1** Multi-detector computed tomography angiography showed the anomalous intra-atrial course of the mid right coronary artery. A: Curved planar reformatting showed the entire course of the right coronary artery (RCA) with a mid-segment with an intra-atrial course; B: Volume rendering technique showed the entire course (green line) of the RCA; C: Cross-sectional images showed the intra-atrial segment of the RCA, which was completely surrounded by blood in the right atrium; D: Curved planar reformatting showed the entire course of the RCA with a mid-intra-atrial course of the artery.

catastrophic lesions during such procedures[2].

## CONCLUSION

MDCTA is a less invasive and less user-dependent method than conventional angiography and can accurately depict the coronary vasculature and its variants of origin, termination, or course[2]. The recognition of an intra-atrial course of the RCA by MDCTA could facilitate avoidance of potential hazards during surgical and/or interventional procedures.

## FOOTNOTES

**Author contributions:** All authors contributed to the study conception and design; Barbiero G, Argiolas A, and Maiolino G performed the patient exam; Barbiero G performed the literature review and wrote the first draft of the manuscript; all authors read and approved the final manuscript.

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