Coronary Sinus to Left Atrium Communication

Almamoon Justaniah[1*], Brady Mckee[1], Jonathan Silver[2], Christoph Wald[1], Sebastian Flacke[1]

1. Department of Radiology, Lahey Hospital & Medical Center, Tufts University School of Medicine, Burlington, Massachusetts, USA

2. Department of Cardiology, Lahey Hospital & Medical Center, Tufts University School of Medicine, Burlington, Massachusetts, USA

* **Correspondence:** Almamoon Justaniah, MD, Department of Radiology, Lahey Hospital & Medical Center, Tufts University School of Medicine, 41 Mall Rd, Burlington, MA 01805, USA
(*dr_justaniah@yahoo.com*)

Radiology Case. 2013 Dec; 7(12):16-20 :: DOI: 10.3941/jrcr.v7i12.1678

ABSTRACT

Coronary sinus anomalies are rare. They can be associated with other vascular anomalies such as persistent left superior vena cava or can occur in isolation. We present a rare case of an isolated coronary sinus communication to the left atrium. This anomaly may be clinically relevant in the setting of significant left-to-right shunting or when shunt reversal results from right-sided heart failure. It may also be significant in cases of persistent atrial fibrillation after attempted pulmonary vein isolation.

CASE REPORT

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A 52-year-old man with a history of smoking, premature coronary artery disease, paroxysmal atrial fibrillation, and prior myocardial infarction with right coronary artery stent presented with back pain and was found to have inferior ST segment elevation on ECG. Cardiac catheterization demonstrated a totally occluded proximal left circumflex artery which was treated with stent placement. Several days following catheterization, he developed a rapid, wide complex tachycardia which was believed to be atrial fibrillation due to an aberrant electric focus. Basic metabolic panel was within normal limits. He continued to have symptomatic paroxysmal atrial fibrillation despite treatment with Digoxin and Amiodarone and ultimately was referred to electrophysiology for an atrial ablation procedure.

The patient underwent pre-ablation pulmonary vein CT angiography, which is the standard protocol at our institution. This was performed following intravenous administration of 80 ml of Omnipaque 350 contrast with bolus tracking on a region of interest over the left atrium (LA), triggering contrast injection at 100 HU. The exam demonstrated normal coronary sinus (CS) drainage into the right atrium (RA). In addition, an anomalous communication between the CS and the inferior aspect of the LA was noted through a bridging vein (Fig 1, 2).

Transesophageal echocardiography (TEE) demonstrated normal flow from the CS into the RA with no ostial stenosis. However, there was a high velocity, turbulent communication between the CS and LA with a narrow color flow jet seen intermittently (Fig 3). Left ventricular (LV) ejection fraction was 40%.

Atrial ablation was performed. During the procedure, a multipurpose catheter was introduced into the CS where contrast injection corroborated the findings of the CT and TEE (Fig 4). Oxygen (O2) saturation measurements throughout the CS showed an increasing O2 gradient towards the left atrium, suggestive of flow from the LA to the CS. The standard Decapolar catheter typically placed in the CS was not used as a result of this anomaly. The remainder of the procedure was performed without complication accomplishing isolation of all pulmonary veins and linear block across the roof of the LA and the mitral isthmus.

At the 3 month follow up visit, the patient complained of episodic chest pain and palpitations. Stress testing induced frequent salvos of non-sustained polymorphic ventricular tachycardia (VT). Electrophysiology study was positive for inducible, sustained monomorphic VT and the patient was implanted with a dual chamber defibrillator. He has remained in sinus rhythm since his ablation.

DISCUSSION

Etiology & demographics

CS anomalies are rare; most cases are reported at autopsy. Mantini's et al. proposed four categories of CS anomalies: Enlarged CS, Absent CS, Atresia of the right atrial-CS ostium, and Hypoplasia of the CS [1]. The Enlarged CS category has two subtypes: Subtype A - without left-to-right shunt and Subtype B - with left-to-right shunt. Subtype B involves a low-pressure left atrial to CS communication, as was seen in our patient. This can occur indirectly by a bridging vein between the CS and LA, as was seen in our patient, or directly through an opening between the CS and LA. To our knowledge, Kim et al. are the only ones categorized the CS to LA communication by a bridging vein as a variant type of unroofed CS [2].

Clinical & imaging findings

In the absence of elevated right heart pressure or CS ostial stenosis, blood will preferentially flow from the LA through the CS and into the RA constituting a left-to-right shunt as demonstrated in our case on echocardiography. Eliot et al. [3] described a fibrous band that narrowed the right atrial ostium of the CS, and Mantini [1] postulated that a connection between the LA and CS may serve to drain the CS in such cases of RA ostium stenosis; however, we did not observe CS ostial stenosis in our patient. In the setting of elevated right-sided pressure resulting from right-sided valvular disease, pulmonary hypertension, COPD, etc reversal of the shunt can occur. Scheller et al. presented a case of CS with two outlets; one to the RA, and the other to the LA [4]. Their patient had right-to-left shunt secondary to RA hypertension following right ventricular infarct.

Clinical presentation will vary according to the presence of arrhythmia as well as the volume and direction of shunting; however this anomaly is most often discovered incidentally in asymptomatic patients. Signs and symptoms of right-to-left shunting may be present in cases of right-sided heart failure. In addition, persistent atrial fibrillation despite pulmonary vein isolation may be seen with the CS/LA interface suspected to be the source of arrhythmia [5].

Diagnosis can be made with CT coronary angiography. Cardiac gating can be useful but is not required and was not performed in our case. TEE and CS venogram may be used to document the direction of flow and shunt volume [4]. MRI is advantageous as it provides detailed anatomical and dynamic information without using ionizing radiation or contrast [6]. Cannulization of the CS for a diagnostic venogram can be challenging in the presence of a Thebesian valve at the CS ostium [4]. One of the advantages of CT over CS venogram is the clear identification of the vascular bridge that connects the CS to the LA. On CS venogram, the appearance of a large CS can be mistaken for an atrial septal defect [7]. In an autopsy of a healthy 18 year old male, Cohle et al. found a large CS communicating both atria that can function as an atrial septal defect [8].

Treatment & prognosis

Intervention is not required in asymptomatic patients. However, awareness of the existence of this anomaly is crucial in planning electrophysiology studies, implantation of CS pacing leads for biventricular devices or in coronary bypass surgery especially when high flow coexists [9]. Neuser et al. suggested epicardial LV lead implantation through an anterior thoracotomy to avoid complications in this setting [10]. Coronary sinus ablation can be considered in patients with known CS sinus anomaly and atrial fibrillation despite prior pulmonary venous isolation.

Differential diagnosis

CS to LA communication can be confused with unroofed CS. The presence of an anomalous bridging vein indirectly communicating the CS to the LA is the main difference. Unroofed CS demonstrates a direct CS to LA communication through a wall defect; the CS is usually enlarged. TEE and CS venogram show bidirectional flow that can be confused for an atrial septal defect. Extent of wall defect can be evaluated by CT or MRI. Unlike our case, unroofed CS is usually associated with other congenital heart diseases and may require surgical correction [11].

TEACHING POINT

In anomalous coronary sinus communication to the left atrium, CT coronary angiography can provide valuable anatomical information for diagnosis and treatment planning. Coronary sinus ablation may be necessary in atrial fibrillation refractory to pulmonary venous isolation.

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FIGURES

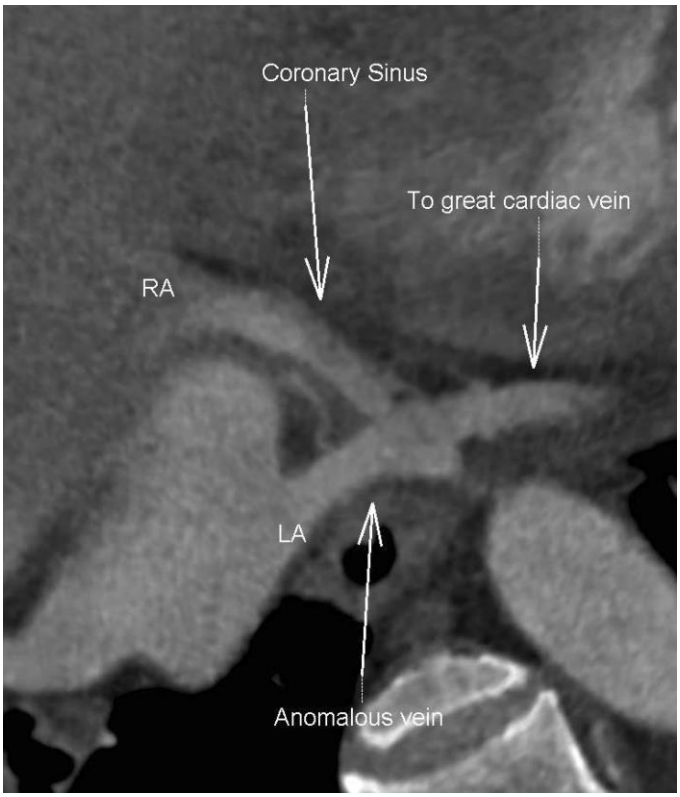

Figure 1: 52 year old male with anomalous coronary sinus communication to the left atrium. FINDINGS: Curved planar reformatted CTA of the pulmonary veins demonstrates an anomalous vein communicating the coronary sinus to the left atrium. TECHNIQUE: Siemens SOMATOM Definition, 12573 mAs, 120 kV, 2mm slice thickness with 0.75mm reconstruction, 80 ml Omnipaque 350, DLP 1519 mGycm, CTDIvol 172.77 mGy.

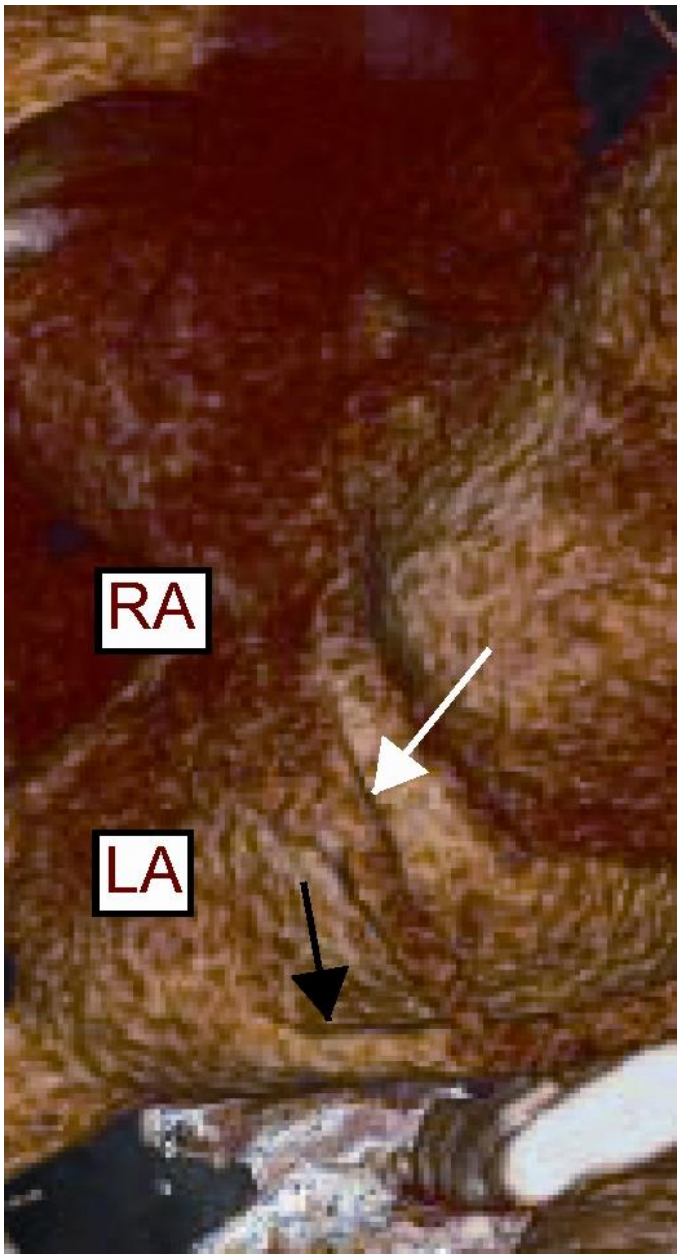

Figure 2: 52 year old male with anomalous coronary sinus communication to the left atrium. FINDINGS: Volume-rendered 3-D image demonstrates the anomalous vein (black arrow) communicating the coronary sinus (white arrow) to the left atrium. TECHNIQUE: Siemens SOMATOM Definition, 12573 mAs, 120 kV, 2mm slice thickness with 0.75mm reconstruction, 80 ml Omnipaque 350, DLP 1519 mGycm, CTDIvol 172.77 mGy.

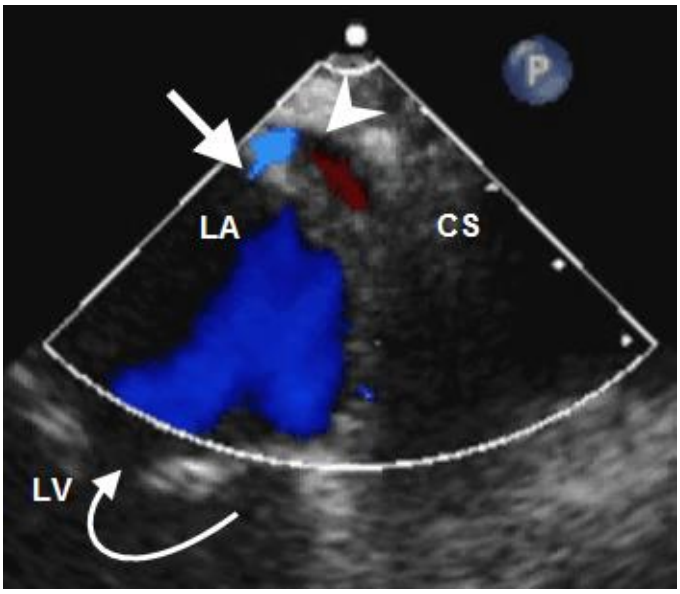

Figure 3: 52 year old male with anomalous coronary sinus communication to the left atrium. FINDINGS: Off-axis transesophageal echocardiogram at early diastole demonstrates the anomalous vein (arrowhead) communicating the coronary sinus to the left atrium. Note the turbulent flow from the left atrium to the coronary sinus (arrow) representing left-to-right shunt. Mitral valve (curved arrow). TECHNIQUE: Two dimensional transesophageal echocardiogram with color Doppler, Phillips S7-2 Omni TEE transducer (2-7 MHz).

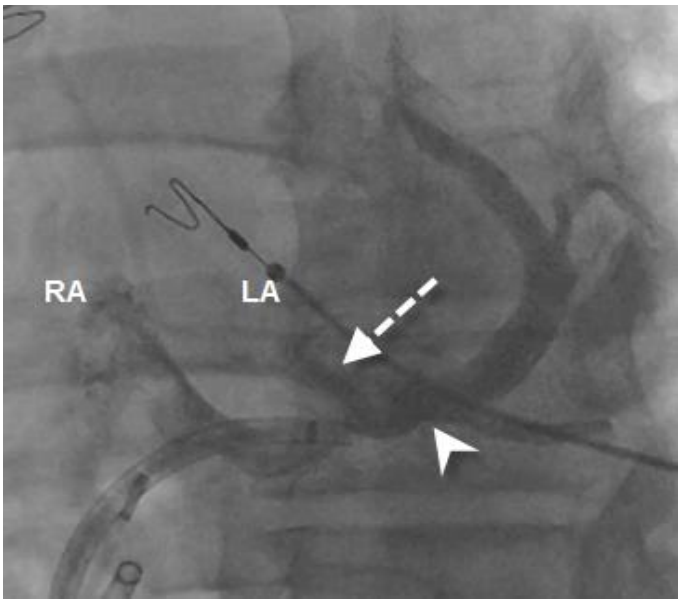

Figure 4: 52 year old male with anomalous coronary sinus communication to the left atrium. FINDINGS: Digital angiography in LAO projection demonstrates partial shunting of contrast from the coronary sinus (arrowhead) to the left atrium through an anomalous bridging vein (arrow). Note the normal flow of the remaining contrast to the right atrium. TECHNIQUE: Digital angiography, Siemens Artis Zee, 110 ml Omnipaque 350, radiation dose 387mGy.

Etiology	**Congenital**
Incidence	**Unknown**
Gender ratio	**Unknown**
Age predilection	**No known age predilection**
Risk factor	**Congenital**
Treatment	**Not needed unless right-to-left shunt occurs**
Prognosis	**Excellent as it is mostly asymptomatic and found in autopsy**
Findings on imaging	**<u>TEE:</u> Normal flow from the coronary sinus into the right atrium. In addition, there is intermittent shunting from the left atrium to the coronary sinus through an anomalous communication.** **<u>CT:</u> Clearly discernable bridging vein indirectly connecting the coronary sinus to the left atrium. Normal coronary sinus size with intact wall.** **<u>Venogram:</u> Coronary sinus to left atrium communication. Increased O2 gradient within the coronary sinus near the left atrium due to left-to-right shunt.**

Table 1: Summary table for coronary sinus to left atrium communication

Entity	TEE Findings	CT Findings	MRI Findings	Cardiac Catheterization
Coronary sinus to left atrium communication	Normal flow from the coronary sinus into the right atrium. In addition, there is intermittent shunting from the left atrium to the coronary sinus through an anomalous communication.	Clearly discernable bridging vein indirectly connecting the coronary sinus to the left atrium. Normal coronary sinus size with intact wall.	Not performed.	Coronary sinus to left atrium communication. Increased O2 gradient within the coronary sinus near the left atrium due to left-to-right shunt.
Unroofed coronary sinus	Right-to-left or left-to-right shunt between the atria. Enlarged coronary sinus [2].	Enlarged unroofed coronary sinus communicating directly with the left atrium [2].	Enlarged pulmonary arteries. Dilated coronary sinus draining into the right atrium and directly communicating with the left atrium. It may appear and function as an atrial septal defect with bidirectional flow between the atria [6].	Bidirectional flow between the atria and elevated pulmonary artery pressure [11].

Table 2: Differential diagnosis table for coronary sinus to left atrium communication

ABBREVIATIONS

CS: Coronary sinus
LA: Left atrium
LV: Left ventricle
O2: Oxygen
RA: Right atrium
TEE: Transesophageal echocardiography
VT: Ventricular tachycardia

KEYWORDS

Coronary sinus anomaly; coronary sinus connection; coronary sinus communication to the left atrium; left-to-right shunt; right-to-left shunt

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