JACC: CASE REPORTS VOL. 3, NO. 4, 2021

MINI-FOCUS ISSUE: ELECTROPHYSIOLOGY

ADVANCED

CASE REPORT: CLINICAL CASE

Coronary Sinus Lead Placement in Patients With Coronary Sinus Ostial Atresia

An Innovative Approach

Ata Bajwa, MD,[a,b] Jashdeep Dhoot, MD,[c] Sanjaya Gupta, MD[a,b]

ABSTRACT

This case series demonstrates 2 innovative approaches to successful coronary sinus lead placement in the setting of coronary sinus ostial atresia. Use of venous phase coronary angiography, a computed tomography scan with venous phase, or a left-sided upper extremity venogram may help reveal a variant anatomy and guide tool selection. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:614–8) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

INTRODUCTION

Prior studies have reported a 2.4% to 5.4% failure rate for placement of coronary sinus (CS) lead during cardiac resynchronization therapy (CRT) device implantation (1). One of the causes of failure is the inability to cannulate the CS because of an anatomic variant. CS ostial atresia (CSOA) is a very rare anomaly in which CS ends in a blind sac instead of opening into the right atrium. Given the lack of an ostium in right atrium, the CS drains the venous blood from the heart via anomalous pathways, persistent left superior vena cava (PLSVC) being the most common (2). This is an otherwise benign condition that comes to attention during invasive cardiac electrophysiology procedures when there is failure to cannulate the CS from the right atrium.

CASE 1

A 42-year-old woman with history of complete heart block status post placement of a right-sided pacemaker presented with recent onset of symptoms of dyspnea on exertion and dependent edema with a decrease in left ventricular ejection fraction to 35% in the setting of 100% right ventricular pacing with a paced QRS duration of 180 ms. During attempted upgrade to CRT with defibrillator, attempts at CS lead placement were thwarted by inability to cannulate the CS, despite multiple attempts. An unsuccessful attempt was also made to localize the CS via placement of a diagnostic electrophysiologic catheter from the right femoral vein. A coronary angiogram was also performed to visualize the venous phase and this failed to reveal a communication from the CS to the right atrium (**Figure 1A**). The procedure was aborted and a cardiac computed tomography scan with venous phase protocol was pursued. Cardiac CT revealed a blind-ended CS without connection to the right atrium that, which was draining into an oblique vein of the left atrium, which connected to a PLSVC, which drained into the left brachiocephalic vein and

From the [a]Saint Luke's Mid America Heart Institute, Kansas City, Missouri, USA; [b]University of Missouri-Kansas City School of Medicine, Kansas City, Missouri, USA; and the [c]Providence Medical Institute, Torrance, California, USA.
The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received November 29, 2020; revised manuscript received January 21, 2021, accepted February 15, 2021.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2021.02.027

LEARNING OBJECTIVES

- Describe how difficulty in engaging the CS should prompt suspicion about coronary CSOA and further testing should be considered to confirm this diagnosis and to evaluate the presence of anomalous venous collaterals.
- Summarize the most common anomalous venous collaterals associated with CSOA and explain how a PLSVC can be used as an alternate route for placement of coronary sinus lead.
- Explain how a left upper extremity venogram can help visualize PLSVC during the case; whereas coronary angiogram, cardiac CT, and cardiac MRI with venous phase protocols can further delineate venous anatomy and confirm the diagnosis of CSOA.
- Describe how knowing the anatomy and size of PLSVC determines the appropriate type of guiding sheaths and subselectors needed for CS lead placement.

subsequently the right-sided superior vena cava (SVC) (Figure 2).

With this new insight, the patient returned to the electrophysiology laboratory for CRT with defibrillator upgrade. Given the patient's existing right-sided pacemaker, initial venous access was obtained in the right axillary vein. A 0.038-inch guidewire was used to reach the SVC and was then directed across to the left brachiocephalic vein using a right-angled CS subselector sheath (Attain Select II, Medtronic Inc., Dublin, Ireland). This was achieved by positioning the right-angled subselector sheath in the SVC and then slow rotating counterclockwise while moving the catheter in a superior direction and continually probing with a hydrophilic guidewire (Glidewire, Terumo Interventional Systems, Somerset, New Jersey). Once the hydrophilic guidewire crossed over to the left brachiocephalic, the inner dilater of the subselector sheath was advanced over the wire and then the subselector sheath was advanced over the dilator in a telescoping manner. From a position in the left brachiocephalic, the right-angled CS subselector sheath was turned counterclockwise until the tip of the sheath engaged the ostia of the PLSVC, which was confirmed by contrast injection (Figure 1B). Next, a 0.038-inch guidewire was advanced into the main body of the CS, followed by the subselector sheath (Figure 1C). Intravenous contrast was injected through the subselector sheath demonstrating a target vessel in the posterolateral branch of the CS. Given the acute angle between the PLSVC/oblique vein of the left atrium and the CS, the right-angle subselector sheath was exchanged for an acute angle subselector sheath over the 0.038-inch wire. The acute angle subselector was then prolapsed into the CS to facilitate access to the posterolateral branch (Figure 1D). Position was confirmed with contrast injection through an inner dilator catheter (Figure 1E). A 0.014-inch guidewire was then used to cannulate the posterolateral branch target vessel and a quadripolar CS lead (Attain Performa 4598, 88 cm, Medtronic Inc.) was then advanced over the wire (Figure 1F). Adequate lead parameters were obtained, and the position was stable on post-procedure chest radiograph (Figure 2). A 12-lead electrocardiogram demonstrated biventricular pacing (Figure 3). An outer CS guide sheath was not used to place this lead, only a subselector sheath to allow for maximal flexibility.

ABBREVIATIONS AND ACRONYMS

CRT = cardiac resynchronization therapy

CS = coronary sinus

CSOA = coronary sinus ostial atresia

PLSVC = persistent left superior vena cava

SVC = superior vena cava

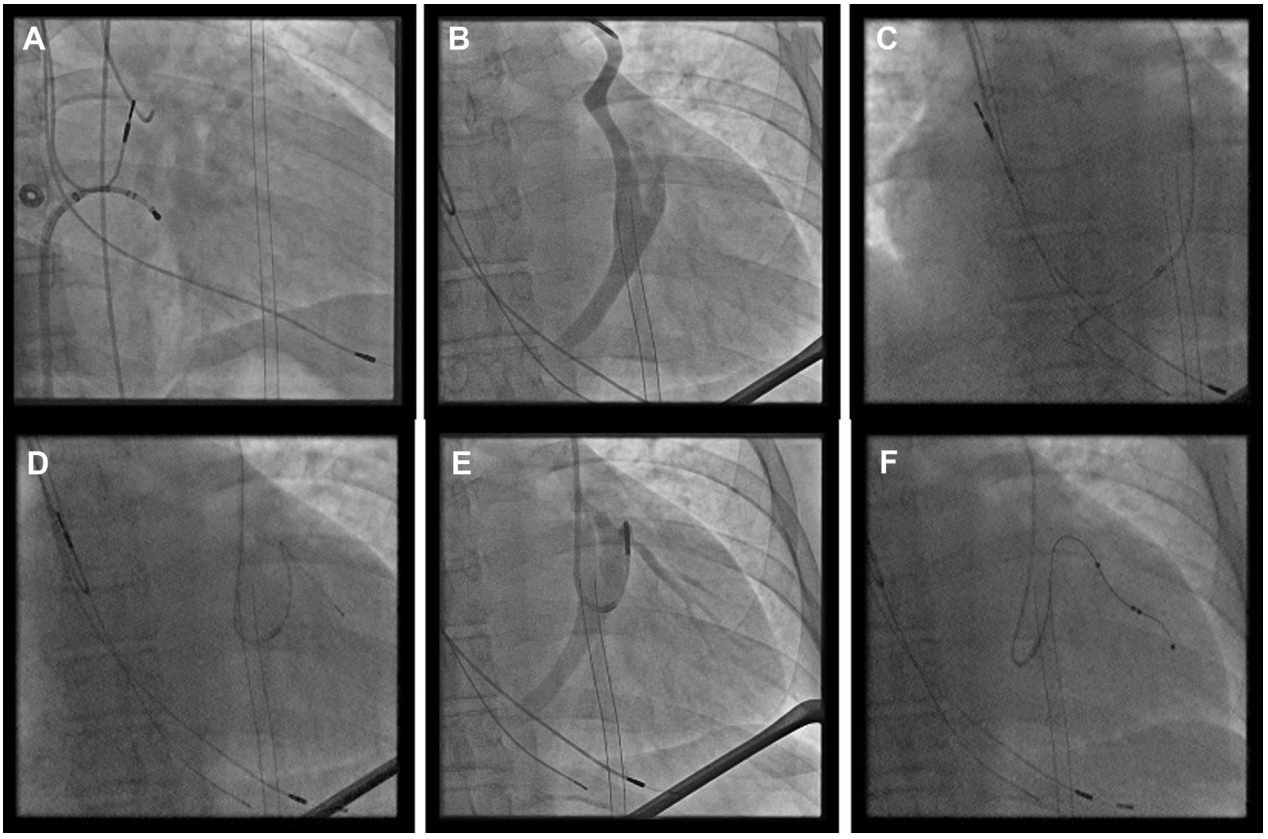
CASE 2

In our second case, a 53-year-old man with a history of nonischemic cardiomyopathy, chronic systolic heart failure with an ejection fraction of 13%, status post dual-chamber implantable cardioverter-defibrillator placement, developed a left bundle branch block with a QRS duration of 150 ms and was undergoing upgrade to CRT with defibrillator. During the procedure, numerous attempts at engaging the CS were made that were unsuccessful. A left upper extremity venogram was performed, which demonstrated a PLSVC.

Using a Vert inner vein selector catheter (Merit Medical, South Jordan, Utah), the PLSVC was successfully engaged. A 0.014-inch coronary guide wire was then advanced into the proximal CS. Balloon occlusive coronary venous angiography was performed through the PLSVC, which demonstrated complete opacification of the CS without contrast flow into the right atrium consistent with CSOA (Figure 4A). Over a 0.014-inch coronary guidewire, the posterolateral branch of the CS was engaged using the Vert inner vein selector catheter. The Vert inner vein selector catheter was then exchanged for a right-angled subselector sheath (Attain Select II, Medtronic Inc.) over a 0.014-inch guidewire. Once the right angled subselector was in place for support and the 0.014-inch guidewire was engaged in the posterolateral branch, a 5-F quadripolar left ventricular lead (Attain Performa 4598, 88 cm, Medtronic Inc.) was advanced over the guidewire to the target vessel.

JACC: CASE REPORTS, VOL. 3, NO. 4, 2021
APRIL 2021:614–8

FIGURE 1



(A) Venous phase of coronary angiography demonstrated coronary sinus (CS) with no contrast entering the right atrium and draining superiorly. A decapolar CS catheter, inserted from the right femoral vein, is near the expected location of the CS ostium. **(B)** Contrast injection of persistent left superior vena cava, oblique vein of left atrium **(arrow)**, and CS. **(C)** Subselect catheter positioned in the CS with a guidewire advanced to the middle cardiac vein but no connection to the right atrium. **(D)** The subselect catheter is prolapsed in the CS with a guidewire in the posterolateral target vessel. **(E)** A subselect catheter with an inner dilator is advanced to the posterolateral target vessel, which is visualized with contrast injection. **(F)** Final position of quadripolar CS lead in the target vessel.

Adequate lead parameters were obtained and position was stable on post-procedure chest radiograph (Figure 4B).

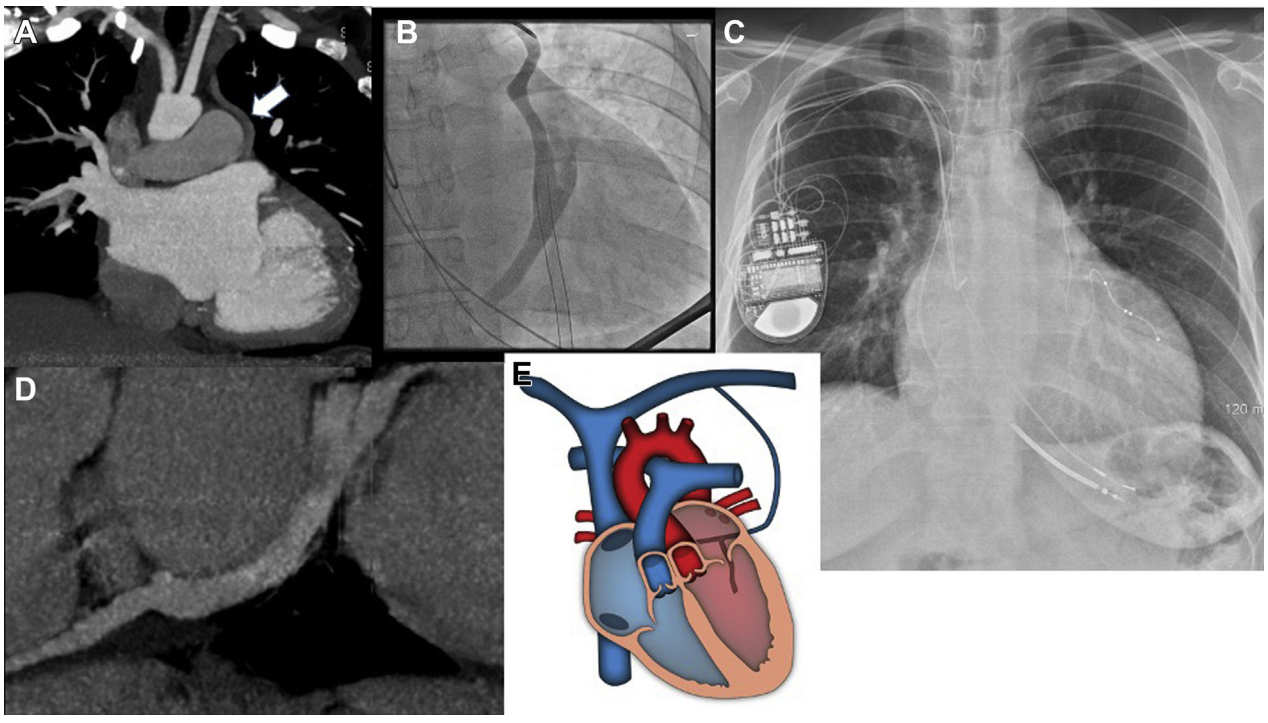
DISCUSSION

CSOA is a rare congenital anomaly with a reported incidence of 0.1% to 0.25% in general population (2,3). In CSOA, the CS lies in a normal position; however, because of the lack of an ostium, it does not drain into the right atrium (2). To drain the venous blood of the heart it tends to be associated with venous collateral pathways. PLSVC is the most common of these pathways with an incidence of 0.21% in the general population. The incidence is much higher in cases with CSOA and is reported to be 40% to 50%.

These anatomic variants pose significant challenges during the implantation of CRT devices. The blind ending of a CS in the right atrium would make it impossible to engage the CS using traditional methods of CS lead placement. Therefore, CSOA should be in the differential diagnosis whenever significant difficulty is encountered engaging a CS during CRT implantation cases. To further evaluate this possibility, a coronary angiogram with venous phase protocol could be considered. In our first case, this demonstrated no connection between CS and right atrium. A cardiac computed tomography with venous phase protocol can also provide further information because it can show the atretic CS and outline the PLSVC.

There have been a few cases reported in the literature where the CS lead was placed via PLSVC in patients with CSOA (3-5). In all of these cases, the CS lead was placed from the left axillary/subclavian venous system. In our first case, CS lead

FIGURE 2 **Case 1: Computed Tomography Scan, Venogram, Chest X-Ray, and Anatomical Illustration**



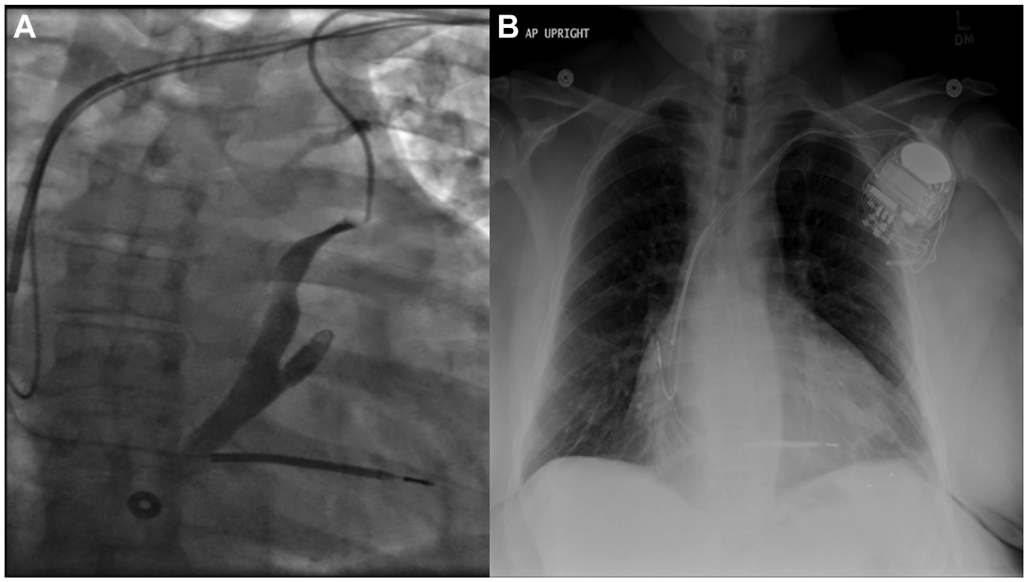
(A) Computed tomography scan showing persistent left superior vena cava connection from left brachiocephalic **(arrow)**. **(B)** Contrast injection of persistent left superior vena cava demonstrating connection to oblique vein of left atrium and then coronary sinus (CS). **(C)** CS lead final position on chest radiograph. **(D)** Computed tomography scan showing oblique vein of left atrium connection to CS with a blind ended pouch without right atrial connection. **(E)** An anatomic drawing indicating a CS with a blind ended pouch without connection to the right atrium with venous drainage via the oblique vein of the left atrium and persistent left superior vena cava.

FIGURE 3 **Electrocardiogram**

A 12-lead electrocardiogram demonstrating biventricular pacing.

JACC: CASE REPORTS, VOL. 3, NO. 4, 2021
APRIL 2021:614–8

FIGURE 4 **Case 2: Venogram and Chest X-Ray**



(A) Venogram showing coronary sinus draining into persistent left superior vena cava without connection to the right atrium. **(B)** Final lead position.

was placed from right axillary vein access and then crossed over from the SVC to the left brachiocephalic vein and subsequently into the PLSVC in order to be delivered to a posterolateral branch of the CS. This lead placement from the right side with the requisite crossing over into the left innominate to reach the PLSVC poses a unique challenge and required a different set of tools than the left-sided CS lead placements previously published. To our knowledge, this is the first reported case of a right-sided CS lead placement in PLSCV, in the setting of CSOA.

This case series demonstrates 2 innovative approaches to successful CS lead placement in the setting of CSOA in the presence of a PLSVC, 1 from a left-sided access and 1 from a right-sided access.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr. Gupta has received modest research grant support from Medtronic; and is a consultant for Boston Scientific and Respicardia. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr. Sanjaya Gupta, Saint Luke's Mid America Heart Institute, 9th Floor, Cardiovascular Research, 4401 Wornall Road, Kansas City, Missouri 64111, USA. E-mail: sgupta@saint-lukes.org.

REFERENCES

1. Gamble JHP, Herring N, Ginks M, Rajappan K, Bashir Y, Betts TR. Procedural success of left ventricular lead placement for cardiac resynchronization therapy: a meta-analysis. J Am Coll Cardiol EP 2016;2:69–77.

2. Shum JS, Kim SM, Choe YH. Multidetector CT and MRI of ostial atresia of the coronary sinus, associated collateral venous pathways and cardiac anomalies. Clin Radiol 2012;67:e47–52.

3. Lim PC, Baskaran L, Ho KL, Teo WS, Ching CK. Coronary sinus ostial atresia and persistent left-sided superior vena cava: clinical significance and strategies for cardiac resynchronization therapy. Int J Angiol 2013;22:199–202.

4. Fujibayashi K, Saeki Y, Sawaguchi J, et al. A case of cardiac resynchronization therapy in a patient with coronary sinus ostial atresia and persistent left superior vena cava. J Cardiol Cases 2019;21:101–3.

5. Stevenhagen J, Meijer A, Bracke FA, van Gelder BM. Coronary sinus atresia and persistent left superior vena cava with the presence of thrombus complicating implantation of a left ventricular pacing lead. Europace 2008;10:384–7.

KEY WORDS biventricular pacemaker, coronary sinus lead, coronary sinus ostial atresia, left persistent superior vena cava