



Contents lists available at ScienceDirect

# Indian Pacing and Electrophysiology Journal

journal homepage: [www.elsevier.com/locate/IPEJ](http://www.elsevier.com/locate/IPEJ)

## Marshall to the rescue in cardiac resynchronization therapy: Left ventricular lead placement in coronary sinus ostial atresia

Ranjit Kumar Nath, Ajay Pratap Singh\*, Dheerendra Kuber, Vatsal Kayal

Department of Cardiology, Atal Bihari Vajpayee Institute of Medical Sciences and Dr. Ram Manohar Lohia Hospital, New Delhi, India



### ARTICLE INFO

#### Article history:

Received 26 August 2021

Received in revised form

26 October 2021

Accepted 6 November 2021

Available online 12 November 2021

#### Keywords:

Congenital anomaly

Coronary sinus

Cardiac resynchronization therapy

Left ventricular lead placement

### ABSTRACT

This case highlights the importance of proper identification of congenital anomalies of the coronary sinus for the successful placement of left ventricular lead during cardiac resynchronization therapy device implantation. We discuss an alternate route for left ventricular lead placement via the vein of Marshall when the coronary sinus ostium in the right atrium was atretic and was facing difficulty initially in detecting the anomaly.

© 2022 Indian Heart Rhythm Society. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

### 1. Case report

A 62-year-old female with heart failure due to dilated cardiomyopathy was referred for cardiac resynchronization therapy-defibrillator (CRT-D) implantation due to persistently low left ventricular ejection fraction (LVEF) of 25% despite optimal medical therapy. She had New York Heart Association (NYHA) class II heart failure symptoms and a left bundle branch block (LBBB) in surface ECG with a QRS duration of 160 milliseconds.

One coronary angiography (CAG) shot of the left coronary artery with levophase imaging was done and showed good-sized target coronary sinus (CS) branches for LV lead placement. Left axillary vascular access was taken after which guidewires were placed into the inferior vena cava (IVC) via the left innominate vein and right atrium (RA). CS cannulation sheath was introduced into the RA and CS entry was attempted, but despite multiple attempts using different shaped catheters CS ostium could not be negotiated, each time wire went into the right ventricle. We then tried engaging the CS ostium using the WEBSTER™ Decapolar catheter (Johnson & Johnson Medical NV/SA 2020) but that also failed to enter the CS ostium. Next, we attempted to engage the CS ostium using

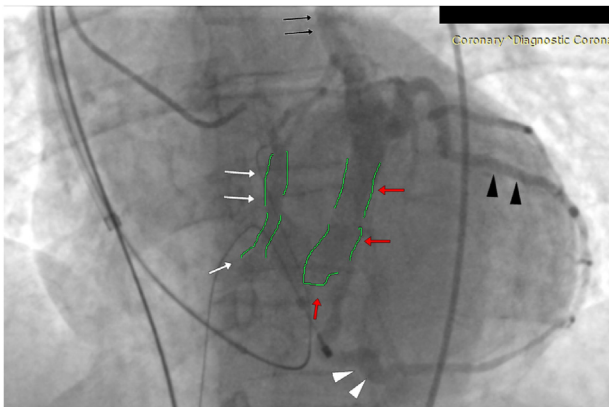
Amplatzer left (AL) catheters but that also failed to delineate the CS ostium. Subsequently, we took few more left-sided CAG shoots in left anterior oblique (LAO) and right anterior oblique (RAO) projections to delineate the CS ostium draining into RA.

Angiograms showed separate draining of the anterior inter-ventricular cardiac vein (AIV) and middle cardiac vein (MCV) into the RA but there was no dye efflux from the body of the CS (Fig. 1). It was also noted that a structure was filling out from the coronary sinus going upward towards the left innominate vein suggesting the presence of vein of Marshall (VOM) (Fig. 1, Black arrows; Video 1) with retrograde flow from CS to innominate vein via persistent rudimentary left-sided superior vena cava (PLSVC). Immediately we took a venogram from the puncture site to look for the vein of Marshall but due to the retrograde flow from CS to the innominate vein it was not visualized, subsequently using a Judkins Right (JR) catheter we were able to cannulate the VOM successfully (Fig. 2; Video 2) and a guidewire was placed in the body of the CS with no communication into RA, which confirmed the atresia of CS ostium. Levophase imaging of angiograms also showed that the good-sized target lateral vein had an acute take-off angle and was draining to the main CS draining via the vein of Marshall. The lateral vein (Fig. 3) was engaged Using a 90° sub-selector and a 0.014" coronary guidewire was advanced into this target vein. Over the guidewire, a quadripolar LV lead (ACUITY™ X4 Quadripolar LV lead, Boston Scientific) was placed deep into the lateral vein with adequate stability and satisfactory pacing and sensing parameters without any diaphragmatic pacing (Video 3). The right atrial and ventricle

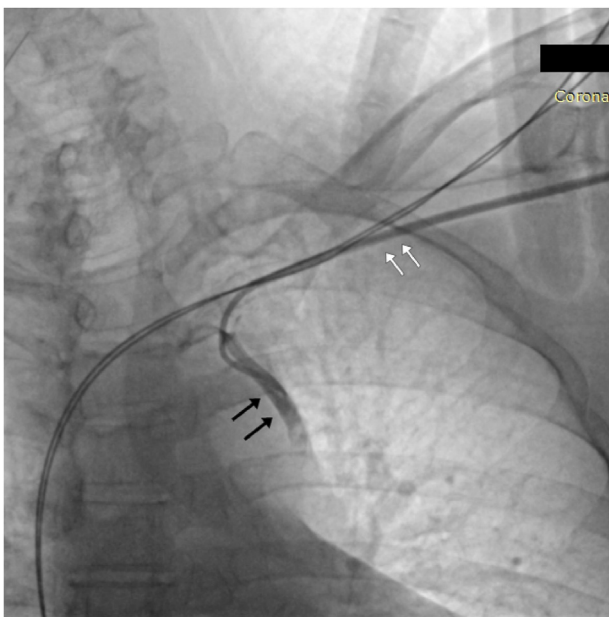
\* Corresponding author. Room no. 229 OPD building, 2nd floor, Department of Cardiology, Dr. RML Hospital, New Delhi, India.

E-mail address: [drajaypratapsingh@outlook.com](mailto:drajaypratapsingh@outlook.com) (A.P. Singh).

Peer review under responsibility of Indian Heart Rhythm Society.



**Fig. 1.** Levophase of left coronary angiogram in LAO (left anterior oblique) projection: Showing two separate openings of the anterior interventricular vein (white arrows) and middle cardiac vein (white arrowheads) along with an atretic coronary sinus (CS) ostium body (red arrows). Target good size lateral vein (black arrowheads) and Vein of Marshall from the body of CS draining towards left innominate vein (black arrows).



**Fig. 2.** Fluoroscopic Image: Selective hooking of Vein of Marshall (black arrows) using a Judkins Right (JR white arrows) catheter.

leads were implanted from the left axillary venous access as done conventionally (Fig. 4).

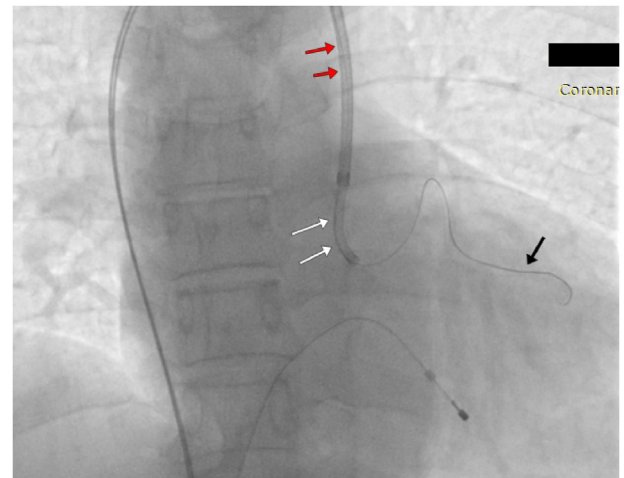
Supplementary data related to this article can be found online at <https://doi.org/10.1016/j.ipej.2021.11.003> Video 1.

Video 2.  
Video 3.

## 2. Discussion

The incidence of left ventricle (LV) lead implantation failure is 3.6% and remains the leading cause of cardiac resynchronization therapy (CRT) failure, and failure to cannulate coronary sinus is the second most common cause after inadequate vein for LV lead placement [1].

A PLSVC is the most common congenital anomaly of the thoracic venous system with an incidence of 0.5% overall and up to 10% in patients with congenital cardiac defects [2]. Typically, 90% of PLSVC are associated with normal right-sided venous connection and



**Fig. 3.** Fluoroscopic image: Engaging the Vein of Marshall using the coronary sinus sheath (red arrow) and cannulating target lateral vein with a guidewire (black arrow) using a 90° vein sub-selector.

drains directly into the CS, deviation from this can be with abnormal drainage (into the left atrium, hepatic vein, or IVC) or abnormalities of the right-sided venous system. Incidence of coronary sinus ostial atresia (CSOA) is extremely rare <0.1% [3] and the combination of CSOA and PLSVC is defined only in 35 cases till now [4]. Up to 30% of patients with PLSVC have the left innominate vein that connects normally to the right-sided SVC [2], as in our case hence offering easy access to the RA via the left axillary access. And due to the retrograde flow of blood from CS due to ostial atresia, it is often missed when a left-sided venogram is performed.

Most patients with PLSVC or CSOA are asymptomatic, and diagnosis is made incidentally when they undergo some imaging in form of computerized tomography or magnetic resonance imaging or intervention like central catheter positions, pacemaker leads implantation, or CRT [2]. Usually, the presence of PLSVC hinders device implantation due to great dilatation of the CS and the branches along with inadequate stability of LV or right ventricular leads [5], but at times as in our case presence of the VOM, draining into the LSVC facilitated the LV lead implantation when access to CS failed from RA. Due to the varied anatomy and pattern of drainage of PLSVC, it is important to determine the opening of LSVC, as unroofed CS is associated with cyanosis and LSVC draining into LA is associated with increased thromboembolism.

A study by Zuo et al. [6] showed that CSOA with a small persistent LSVC (sPLSVC) facilitated LV lead placement into the desired CS branch in 20 patients and among those 40% of patients had one attempt of failed LV lead placement previously. They concluded that levophase CAG in LAO is the best projection to look for sPLSVC and its drainage into RA. In this case, also identification of the VOM and PLSVC was in the LAO projection of the levophase of left-sided CAG, as it separated the opening of AIV and MCV into RA and the atretic ostium of the CS.

Implanting LV lead via VOM/LSVC is challenging due to acute or even 180° turn out of branches into the great cardiac vein. In such cases cannulation of the target vein is assisted using special hook catheters or angled vein sub-selectors [7]. In our case also the target lateral vein take-off angle was acute, and engagement was done using a 90° vein sub-selector. Deep engagement of the wire into the target vein facilitates placement and adequate stability to the LV lead in the target vein [7]. In our case, we looped the LV lead in the



**Fig. 4.** Fluoroscopic Image: Showing right atrial lead (Black arrows), right ventricular lead (white arrows), and left ventricular lead (red arrows) with an adequate loop in coronary sinus body.

body of the CS, as it is necessary to leave enough LV lead slack to accommodate the chest expansion during respiration [7]. CS atresia in our case was congenital but acquired stenosis or complete occlusion should be considered in patients with a history of valve repair surgery or mitral valve annuloplasty. Regardless of the etiology, CSOA complicates the LV lead placement whenever it is difficult to access the CS from RA as in our case.

### 3. Conclusion

This case illustrates the importance of adequate knowledge of CS anomalies during LV lead implantation. Unless suspected, it can lead to failure to place the LV lead in CRT cases.

### Declaration of competing interest

None.

### 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. *JACC Clin Electrophysiol* 2016;2(1):69–77. <https://doi.org/10.1016/j.jacep.2015.08.009>. Epub 2015 Nov 10. PMID: 29766856.
- [2] Irwin RB, Greaves M, Schmitt M. Left superior vena cava: revisited. *European Heart J Cardiovas Imag* 2012;13(Issue 4):284–91. <https://doi.org/10.1093/ehjci/jes017>.
- [3] 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(12):e47–52. <https://doi.org/10.1016/j.crad.2012.07.013>. Epub 2012 Sep 10. PMID: 22974567.
- [4] Jha NK, Gogna A, Tan TH, Wong KY, Shankar S. Atresia of coronary sinus ostium with retrograde drainage via persistent left superior vena cava. *Ann Thorac Surg* 2003;76(6):2091–2. [https://doi.org/10.1016/s0003-4975\(03\)01040-3](https://doi.org/10.1016/s0003-4975(03)01040-3).
- [5] Petrac D, Radeljic V, Pavlovic N, Manola S, Delic-Brkljacic D. Persistent left superior vena cava in patients undergoing cardiac device implantation: clinical and long-term data. *Cardiol Res* 2013;4(2):64–7. PMID: 28352422; PMCID: PMC5358215.
- [6] Zou F, Worley SJ, Steen T, McKillop M, Padala S, O'Donoghue S, Candemir B, Kanjwal K, Kaufman M, Mouram S, Sellers M, Strouse D, Thomaides A, Nair D, Hadadi CA, Kushnir A. The combination of coronary sinus ostial atresia/abnormalities and a small persistent left superior vena cava—Opportunity for left ventricular lead implantation and unrecognized source of thromboembolic stroke. *Heart Rhythm* 2021;18(7):1064–73. <https://doi.org/10.1016/j.hrthm.2021.05.004>. Epub 2021 May 8. PMID: 33971333.
- [7] Worley SJ. Challenging implants require tools and techniques not tips and tricks. *Card Electrophysiol Clin* 2019;11(1):75–87. <https://doi.org/10.1016/j.ccep.2018.11.003>.