A New Road to CRT: Patent Vein of Marshall for Left Ventricular Lead Implantation

Cyrus Hadadi  
Seth Worley  
Torkel Steen  
Matthew Sellers  
Athanasios Thomaides  
Susan O'Donoghue  
David Strouse  
Santosh Padala  
Babar Candemir  
Mathew McKillop  
Michael Kaufmann  
Khalil Kanjwal  
Devi Nair  
Alexander Kushnir

**Introduction:** Coronary sinus anomalies, including coronary sinus ostial atresia, atypical right atrial drainage and unroofed coronary sinus, complicate implantation of a left ventricular pacemaker lead for cardiac resynchronization therapy. In many of the above CS anomalies, coronary venous return will flow retrograde through a patent vein of Marshall to the innominate vein. We report a series of cases from multiple international centers of patients with coronary sinus anomalies where a PVOM was utilized for left ventricular (LV) lead placement.

**Methods:** We reviewed the data on 20 patients where a patent vein of Marshall was identified & used to attempt LV lead placement in order to better understand: 1. Clinical circumstances that lead to the discovery of the PVOM. 2. Imaging techniques used to identify the PVOM. 3. CS anomalies were associated with a PVOM. 4. Physical characteristics of the PVOM. 5. How the PVOM was used to facilitate attempted LV lead placement. 6. Potential complications associated with using a PVOM for LV lead placement.

**Result:** Clinical Characteristics: 44% had at least one previously unsuccessful attempt at LV lead placement due to inability to find or cannulate the CS. 22% had been referred for epicardial LV leads. Imaging Techniques: The PVOM was identified by catheter manipulation & contrast injection in 72% and identified via levophase CS venography in 28%. In 2 cases prior dedicated cardiac CT did not reveal the PVOM, however in 1 case cardiac CT did demonstrate the PVOM pre-procedure. CS Anomalies & Characteristics: 33% of PVOM were associated with an unroofed CS. The average PVOM measured 5.3 mm in diameter. LV Lead Implantation: LV lead implantation was successful in 89% of cases, with implant directly down the PVOM in 80% of cases. In 1 case subclavian venoplasty was necessary prior to identification of the PVOM, and in 1 case CS venoplasty and snaring the circumference of the PVOM was necessary in order to advance the LV lead into the CS. Complications: In 1 case the patient experienced a stroke during implantation secondary to an unroofed CS.

**Conclusion:** Coronary sinus anomalies are rare congenital and iatrogenic anatomic variants that complicate implantation of a left ventricular pacemaker lead for cardiac resynchronization therapy.
Searching for, finding and utilizing a patent vein of Marshall can achieve successful lead implantation.