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Case Report

Percutaneous Extraction of ICD Lead Placed through a Persistent Left-Sided Superior Vena Cava with Right Superior Vena Cava Atresia

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Abstract

A 47 year old female with a history of non-ischemic cardiomyopathy and a defibrillator system presented for an infected ICD pocket site, two months after an elective generator change out. The patient was transferred to our institution after a failed lead extraction. During the index procedure, it was discovered she had the RV defibrillation lead implanted via a persistent left-sided SVC. During our preoperative workup, a CT chest was performed which revealed she had a persistent left sided SVC and an absent right-side SVC. Given her infected device, we proceeded with an extraction procedure using a 16 Fr Spectranetics laser sheath. Notably, we did not use the outer sheath in order to allow the laser sheath to traverse around the acute angles of the lead. The procedure was successful without any complications. After completion of antibiotics, the patient underwent re-implantation of a defibrillator system from the right subclavian vein, across to the left subclavian and down the left-sided SVC, and on clinic follow up, the patient has been doing well with normal device parameters.

ABBREVIATIONS

PLSVC: Persistent Left-Sided Superior Vena Cava; ICD: Implantable Cardiac Defibrillator; RV: Right Ventricle; TV: Tricuspid Valve

INTRODUCTION

Persistent Left Superior Vena Cava (PLSVC) is a common thoracic venous anomaly, occurring in 0.5-2% of the general population and up to 10-12% of individuals with concomitant congenital cardiac defects [1,2]. In 10-20% of PLSVC cases, the right vena cava is absent, a variant also referred to as isolated PLSVC[2]. Generally considered a benign condition, isolated PLSVC may have important clinical implications. Previous case reports have documented challenges in placing transvenous leads [3-6]; we present here the first case report of a successful lead extraction in a patient with a transvenous ICD system and isolated PLSVC.

CASE PRESENTATION

A 47-year-old woman with a history of non-ischemic, dilated cardiomyopathy presented with an ICD pocket infection following an ICD generator replacement. The patient underwent placement of a dual-chamber ICD (Medtronic Virtuosos DR device) with a Medtronic atrial lead (model 5076-58) and Medtronic single-coil ICD lead (model 6935-75) in June of 2011 for primary prevention in the context of non-ischemic cardiomyopathy and an ejection fraction of 15%. This was presumed to be secondary from post-partum cardiomyopathy that did not recover with medical therapy. A generator replacement was done in April of 2016 (Figure 1).

She subsequently presented to an outside institution with erythema at the incision site and purulent drainage. She was started on IV vancomycin and a lead extraction was attempted. During this initial procedure, it became evident that the leads had been placed through a PLSVC. The atrial lead was successfully removed. However, due to the complexity of the venous anatomy, the extraction of the remaining ICD lead was aborted and the patient was transferred to our institution for extraction of the ICD lead (Figure 1).

The pre-operative chest x-ray is demonstrated in Figure (2). A Chest CT obtained prior to the extraction showed absence of the right superior vena cava and persistent left superior vena cava with a single ICD lead extending via the PLSVC to the right ventricular apex as depicted in Figures (3A-3C). A transthoracic echocardiogram demonstrated a severely depressed systolic

function with an ejection fraction (EF) of 15%, moderate to severe mitral valve regurgitation, and moderate pulmonary hypertension.

In a hybrid operating room the patient was placed under general anesthesia. Intraoperative transesophageal echocardiogram was performed, demonstrating a small vegetation of 1.2 x 1.6 cm attached to the ICD lead near the tricuspid valve. The previous incision was opened and a large amount of purulent material was evacuated. The infected pocket, ICD capsule, and subcutaneous tissue were debrided. The ICD lead was freed up to its insertion point at the subclavian vein and prepared for extraction by securing the lead body and shock coil cables to the locking stylet that had been placed during the initial attempted extraction.

Traction alone could not remove the lead and a 16 F laser sheath (Spectranetics, Colorado Springs, CO) was therefore loaded onto the ICD lead as show in fluoroscopy image (Figure 4A). An outer sheath was not used as it was felt to add unnecessary stiffness to the laser sheath that had to make multiple acute angle turns. The laser sheath was then advanced under fluoroscopic guidance. Resistance was noted in the subclavian vein, requiring laser energy application. Laser application was not needed though the PLSVC but adhesions were again noted as the lead turned towards the right ventricle (RV), at the level of the Tricuspid Valve (TV) requiring additional laser applications (Figure 4B). At the level of the TV attention was paid to the traction on the lead which reduced the sharp curvature of the lead. The absence of the outer sheath also allowed for significantly increased maneuverability of the laser sheath.

Inside the RV the ICD coil was freed from adhesions using laser applications, and the lead was completely extracted (Figure 4C, Figure 5). Hemostasis was achieved via a figure-of-eight suture over the subclavian vein entry site. The wound was irrigated with antibiotic-containing saline, and a wound VAC sponge was placed inside the pocket. An occlusive dressing and suction were applied. A post-operative transesophageal echocardiogram did not reveal a pericardial effusion, and there was mild tricuspid regurgitation. The patient remained stable throughout the entire procedure and was given a wearable defibrillator at the time of discharge in anticipation of a right-sided ICD implantation.

Follow up of blood, wound and lead cultures prior to the extraction did not grow any organisms. After completion of

Figure 1 Timeline of patient's clinical course.

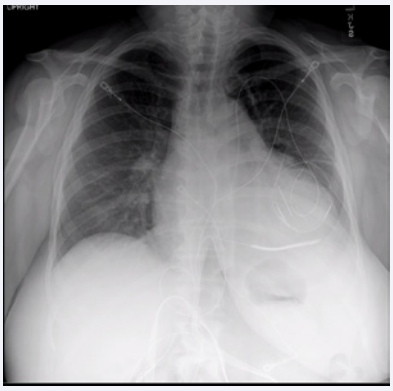

Figure 2 Preoperative CXR showing ICD ventricular lead coursing through the persistent left-sided superior vena cava.

Figure 3a Preoperative CT scan showing persistent left sided SVC course of ICD lead beginning in the left subclavian vein and then joining the left-sided SVC.

Figure 3b Preoperative CT scan showing persistent left-sided SVC with right SVC atresia.

Figure 3c CT scan showing continued course of ICD lead through the tricuspid valve.

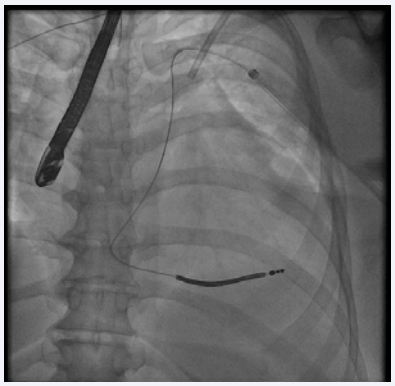

Figure 4a Fluoroscopy image at beginning of extraction with laser sheath as it enters the left subclavian vein.

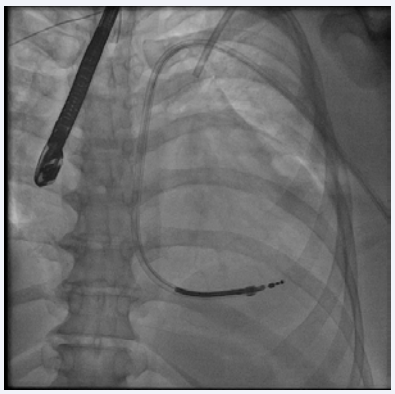

Figure 4b Fluoroscopy showing tracking of laser sheath through the tricuspid valve along the ICD lead. Notice no outer sheath is used in order to negotiate the acute course across the valve.

antibiotics, the patient underwent implant of a dual chamber right-sided ICD on 9/29/2016. Due to her anatomy, a right subclavian access was performed with the leads traversing to the left subclavian vein, coursing through the left SVC, into the coronary sinus and into the atrium and RV septum (Figure 6). On our last clinic follow-up on 12/6/2016, her wound has healed well, and the patient has not had any sustained ventricular arrhythmias that required ICD therapy.

DISCUSSION

PLSVC generally exists in two forms. The first, in which the right-sided SVC remains, accounts for 90-92% of cases. The second, with an associated agenesis of the right SVC accounts for 8-10% of cases [1,2]. Variants of PLSVC may be significant. In 80-90% of cases the PLSVC drains into the right atrium, while 10-20% of cases drain into the left atrium, resulting in a right-to-left shunt [7]. When the PLSVC drains into the right atrium, it is

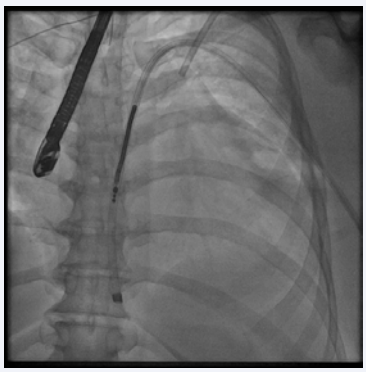

Figure 4c Fluoroscopy image showing successful extraction.

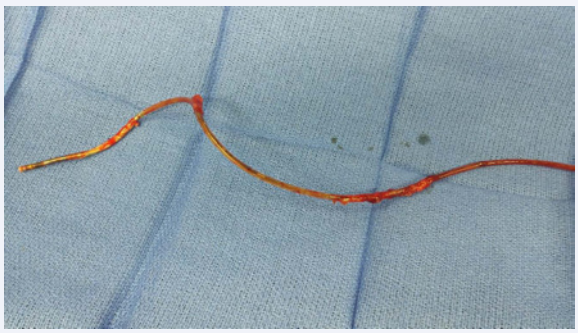

Figure 5 ICD Lead immediately following extraction. Here the shape of the lead indicates its course through the left-sided SVC and across the tricuspid valve.

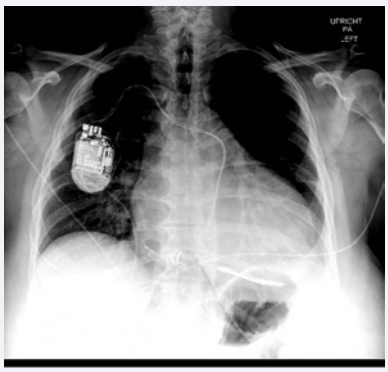

Figure 6 Post-operative CXR after re-implantaiton. Both atrial and right ventricular ICD leads course from a right subclavian access to the left subclavian vein, down the left-sided SVC, through the coronary sinus and into the atrium and ventricle.

primarily through the coronary sinus [1-2].

This condition arises due to the left and right pre-cardinal veins forming during the fourth week of embryogenesis and draining the upper extremities into the heart. By the eighth week of embryogenesis, an anastomosis forms between the left and right pre-cardinal veins, and the left cardinal vein inferior to this anastomosis begins to atrophy and eventually obliterates, becoming the Ligament of Marshall. The anastomosis eventually becomes the left innominate vein and the right pre-cardinal vein becomes the SVC (Figure 7). Failure of the left inferior pre-cardinal vein to obliterate leads to the condition of a left-sided SVC [3].

While considered benign, the condition does carry important clinical implications. PLSVC can create technical difficulties when accessing or manipulating the left subclavian vein during transvenous procedures such as right heart catheterization, central venous catheterization, pacemaker and ICD lead implantation, or as presented here, lead extractions.

A large number of case reports exist in the literature describing transvenous lead placement in PLSVC [4-7]. Most case reports discuss placement of pacemaker leads via a PLSVC. However, there are also reports of ICD lead placements, including one report on ICD lead implantation in PLSVC with right SVC atresia [4]. These case reports consistently describe technical challenges with transvenous lead placement, specifically placement of the ICD lead along the RV apical septum. Despite the technical challenge, increased procedure and fluoroscopy time, a number of scenarios would lead the operator to place a device system through the PLSVC. In patients where high defibrillator thresholds maybe a possibility, the operator may still choose to place the defibrillator system from the left subclavian to optimize the defibrillation vector. Another scenario where an operator may choose to implant via a left SVC would be of a previously right-sided implant that has been infected and now contralateral re-implant is preferable to avoid a previously infected pocket. Furthermore, in the anatomical variant where there is no right SVC, the only access is via through the PLSVC. On the other hand, placement of a pacing system does not require the generator to be on the left side due to no need for defibrillation, and allows the flexibility of the operator either to implant via the right side if a right-sided SVC is present.

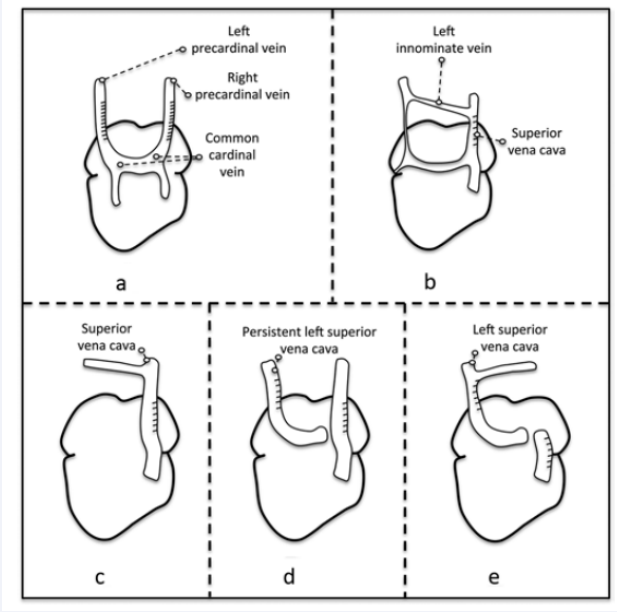

Figure 7 Figure adopted from Rossi U et al. (A) Posterior view of the heart and the left and right pre-cardinal veins. (B) Anastomosis forms at the 8th week of gestation that will eventually become the left innominate vein. Obliteration of the left cardinal vein inferior to this anastomosis eventually becomes the Ligament of Marshal and forms (C).Normal anatomy. Failure of this obliteration leads to (D) The double SVC variant. Regression of the right cardinal vein leads to (E) The Left SVC with right SVC atresia variant.

While implantation techniques have been described in detail, very little data exists on extraction techniques and outcomes. Polewczyk et al., described complications of permanent pacing in 11 patients with PLSVC at single-center retrospective analysis [8]. Two patients in the study underwent successful transvenous extractions of their pacemaker leads. There is no data available on lead extractions of ICD leads placed in PLSVC.

Extractions of pacemaker and ICD leads in patients with PLSVC are likely to become increasingly relevant. As the indications for cardiac implantable electronic devices increase, so too does the need for lead extractions [9]. Similarly, limited venous access in many patients may also necessitate increased use of PLSVC for lead placement.

In patients with an infected ICD system, lead extraction is a class I indication [10]. The procedure is generally considered safe with major complication rates less than 2% and in-hospital mortality rates less than 1% [11,12]. However leads placed via non-traditional approaches or via abnormal anatomy present unique extraction challenges.

A thorough preoperative evaluation is always imperative and should include a chest X-ray and echocardiogram. With PLSVC, chest X-ray will demonstrate an abnormal course of the lead (Figure 1). PLSVC may be further suspected by an enlarged coronary sinus seen on echocardiogram and can be confirmed via a bilateral bubble study [1]. Chest CT with contrast may further help delineate venous anatomy, as seen in this case.

As demonstrated in this case there are several factors to keep in mind when extracting ICD leads in patients with a PLSVC. Traction alone may not suffice to remove these leads as have been previously described in patients with normal anatomy. Additional tools such as locking stylets, laser sheaths, and mechanical dilator sheaths may not only be required, but can be used safely in these patients with PLSVC. Due to a potential 90 degree turn from the subclavian vein into the PLSV and another 180 degree turn from the CS through the tricuspid valve into the right ventricle, one should consider only using the inner laser sheath, avoiding the use of an outer sheath. Use of an outer sheath increases the rigidity of the laser system, allowing more support for pushability at the expense of flexibility, making negotiation of a laser sheath around these acute angles difficult. It is important to be aware of adhesion formation at the tricuspid annulus which may be more challenging to negotiate due to the curvature of the lead. The appropriate amount of traction will therefore be

needed to straighten the curvature of the lead as it crosses the tricuspid valve. In instances where calcifications form around these acute angles, it may be difficult to free these adhesions with both laser and mechanical dilators. If the risks of cardiac injury and venous perforation outweigh the benefit of lead removal, the operator may have to consider capping and abandoning the lead. Lastly, the thin walled nature of the coronary sinus should be kept in mind and laser energy application and traction in this region should be minimized.

Should a vascular injury occur in the PLSCV or CS one should remember that these structures are located on the posterior surface of the heart, specifically the coronary sinus traverses along the posterior left atrial-ventricular groove. Any repair in this area will require institution of cardio pulmonary bypass to ensure hemodynamic stability and allow adequate visualization to perform the repair.

CONCLUSION

PLSVC is a common venous anomaly which may be used for transvenous lead placement. Knowledge of the venous anatomy and careful planning of the procedure is critical for lead implantation and is equally important when a lead extraction is needed. As demonstrated in this case there are specific extraction considerations to be made for ICD leads placed via the PLSVC but with experienced operators, and the appropriate technologies and facilities, ICD leads placed via the PLSVC may be safely and successfully extracted.

KEY TEACHING POINTS

-PLSVC is a benign common venous anomaly, which may have important clinical implications in regards to device implantation and future lead management

-Careful pre-procedural planning is necessary and includes at minimum a chest X-ray and echocardiogram

-ICD lead extraction through a PLSVC can be done successfully with experienced operators and appropriate technique

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