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CASE REPORT

Imaging evaluation of a persistent left superior vena cava and its importance in electrophysiologic procedures

Victoria J. Smith[1] | Taylor A. Klein[2] | Hany N. Demo[3]

[1]St Joseph's Medical Center, Stockton, California, USA
[2]Conemaugh Memorial Medical Center, Johnstown, Pennsylvania, USA
[3]Department of Cardiac Electrophysiology, Swedish Hospital - Northshore Healthsystem, Chicago, Illinois, USA

Correspondence
Victoria J. Smith, St Joseph's Medical Center, 1800 N California St., Stockton, CA 95204, USA.
Email: victoria.smith901@commonspirit.org

Abstract
Accurate characterization of thoracic vascular structures is essential to safe, efficient, and successful cardiac electrophysiologic procedures. Here we describe a case of persistent left superior vena cava incidentally discovered during an elective cryoablation of atrial fibrillation procedure to illustrate possible diagnostic modalities to identify vascular abnormalities.

KEYWORDS
agitated saline study, bubble study, cardiovascular disorders, electrophysiologic procedures, vascular abnormalities

1 | INTRODUCTION

Of all thoracic venous abnormalities, a persistent left superior vena cava (PLSVC) is the most common with a prevalence of 0.3–0.5% of the general population.[1] Characterizing venous abnormalities has gained importance in electrophysiologic (EP) procedures due to possible complications with ICD lead placement and ectopic foci isolation during ablations. For example, patients with PLSVC usually have an enlarged coronary sinus (CS), which can displace the His bundle along with the slow pathway in the setting of atrioventricular nodal reentrant tachycardia (AVNRT).[2] Additionally, PLSVCs have been implicated in the initiation and maintenance of atrial fibrillation due to shared embryologic origin with the Ligament of Marshall.[3] As such, the discovery of an enlarged CS should prompt a thorough workup for possible PLSVC.

2 | CASE

A 69-year-old woman presented for an elective cryoablation for atrial fibrillation. During the procedure, an intracardiac echocardiogram (ICE) identified a visibly dilated coronary sinus (CS) (Figure 1A) when the ICE catheter was advanced into the right atrium, resulting in clinical suspicion of persistent left superior vena cava (PLSVC), further depicted in the video clip (Video S1). Upon discovery of the enlarged CS, a bubble study was conducted with agitated saline injected via left antecubital fossa venous access. After under two seconds, (Figure 1B) agitated saline was observed flowing from the CS into the right atrium (RA) (black arrow), confirming the presence of a PLSVC. Video of bubble study included (Video S2).

During the procedure, EnSite Precision™ Cardiac Mapping System was used to construct a three-dimensional anatomical map (Figure 1C). Cardiovascular geometry was

Dr. Hany Demo serves as a consultant for Medtronics & St. Jude.

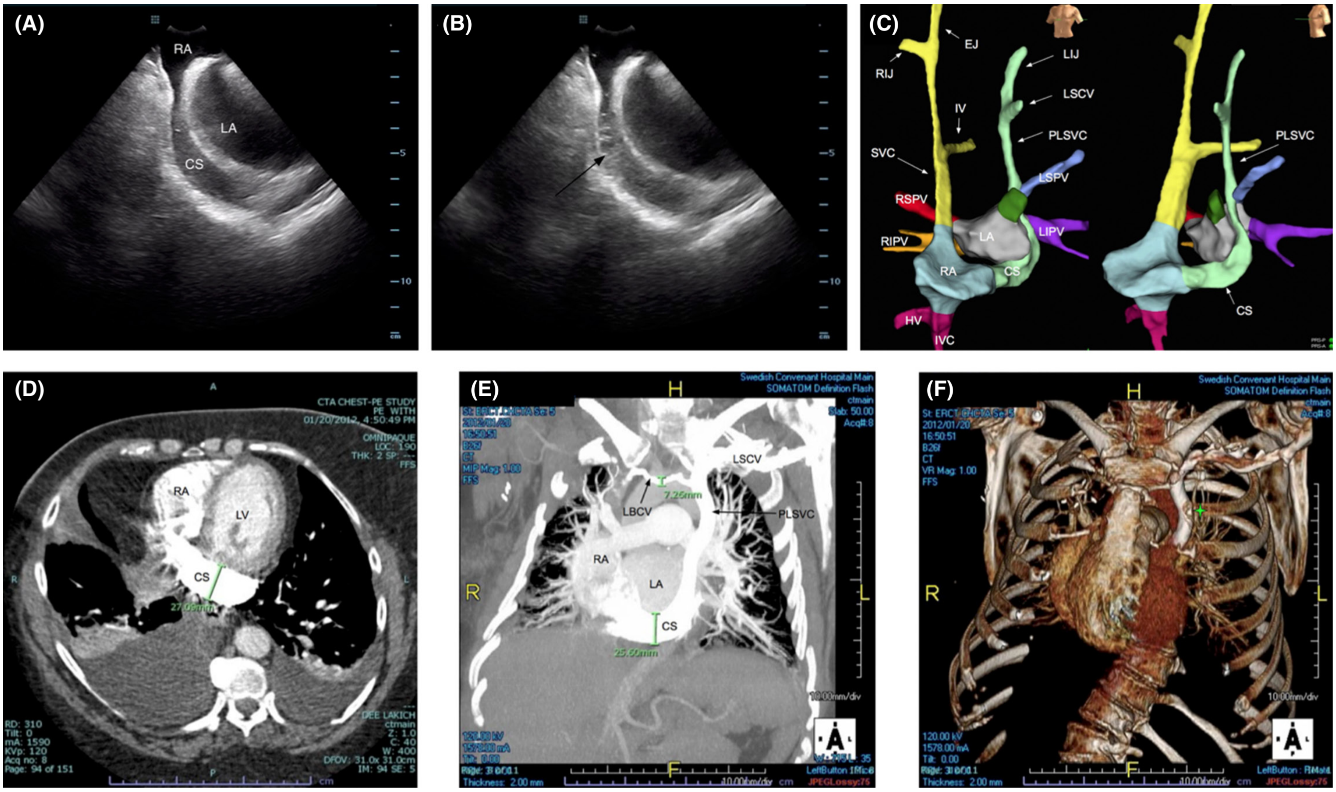

FIGURE 1 Imaging of persistent left superior vena cava and enlarged coronary sinus. (A) Intracardiac echocardiogram image (ICE) of enlarged coronary sinus (CS). (B) ICE image visualizing agitated saline passing within the CS (black arrow) less than two seconds after injection of agitated saline in the left antecubital vein. (C) 3-Dimensional anatomical cardiac mapping. Orientation markers indicate an AP view (left) and a left lateral view (right). (D) Transverse view of the chest from a computed tomography angiogram (CTA) demonstrating an enlarged CS measuring 27.09 mm in diameter. (E) Coronal view of the chest from a CTA demonstrating a contrast within the left subclavian vein (LSV), the persistent left superior vena cava (PLSVC) and the coronary sinus (CS). CS diameter measures to 25.60 mm. Left brachiocephalic vein (LBCV) diameter measures at 7.26 mm. (F) 3D reconstruction of contrast CTA demonstrating a PLSVC (green marker). [CS, coronary sinus; EJ, external jugular; HV, hepatic vein; IV, innominate vein; IVC, inferior vena cava; LA, left atrium; LIJ, left internal jugular; LIPV, left inferior pulmonary vein; LSCV, left subclavian vein; LSPV, left superior pulmonary vein; LV, left ventricle; PLSVC, persistent left superior vena cava; RA, right atrium; RIJ, right internal jugular; RIPV, right inferior pulmonary vein; RSPV, right superior pulmonary vein; SVC, superior vena cava]

collected by advancing the diagnostic catheter from the RA, into the CS and up the PLSVC. Following completion of cryoablation, the ICE catheter was advanced into the CS and an ultrasound survey of the heart was conducted (Video S3).

After a successful procedure, previous imaging studies were reviewed for evidence of PLSVC. A transthoracic echocardiogram (TTE) was performed a year prior to ablation to assess ejection fraction in the setting of atrial fibrillation. TTE images with a parasternal long-axis view displayed an enlarged CS measuring to 2.5 cm (Figure S1A and B). Two months prior to ablation, a transesophageal echocardiogram (TEE) was performed after presentation to the ED due to atrial fibrillation with rapid ventricular response. The images acquired during this study also demonstrated a severely dilated CS (Figure S2A-E, Video S4).

Further review resulted in discovery of a chest computed tomography angiography (CTA) taken 7 years prior to ablation to rule out pulmonary embolism. This study utilized contrast via the left upper extremity, which allowed for visualization of the left subclavian vein (LSCV) and PLSVC into the CS. A transverse view measured the CS at 27.09 mm in diameter (**Figure 1D**). The coronal view allowed further visualization of the PLSVC with CS enlargement and atrophy of the left brachiocephalic vein (LBCV)(**Figure 1E**). The CS diameter measures 25.60 mm, twice the normal value (12 mm ± 2 mm). The LBCV diameter measures 7.26 mm, half the normal value (approximately 14 mm).

A 3D CTA reconstruction further offered visualization of the PLSVC (**Figure 1F**).

3 | CONCLUSION

The persistent left superior vena cava is a common venous abnormality that is important to consider when planning electrophysiologic procedures such as ICD lead placement and ablation. Correctly identifying a PLSVC is important when placing an ICD lead using left subclavian vein access due to the changes in anatomy. The PLSVC can result in atrophy of the left brachiocephalic vein, which is a common route of ICD lead placement. Identification is also important for atrial fibrillation ablation procedures because ectopic foci can arise in the PLSVC due to its shared embryologic origin with the Ligament of Marshall.[4] If an enlarged CS is visualized during either procedure, we suggest further evaluation with a bubble study to confirm the presence of a PLSVC.

AUTHOR CONTRIBUTIONS

VJS involved in acquisition of literature, design of manuscript, draft of manuscript, and editing of images. TAK involved in acquisition of literature, editing of images, and helped draft manuscript. HND involved in conception of manuscript, critically revised the manuscript, and production of imaging. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

Victoria J. Smith, DO; Taylor A. Klein, DO; and Hany N. Demo, MD, have declared that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ETHICAL APPROVAL

This article does not contain any studies with human or animal subjects. There are no patient identifiers.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

ORCID

Victoria J. Smith https://orcid.org/0000-0003-3276-5131

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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