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CASE REPORT

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# A hazardous collateral pathway following asymptomatic lead-related venous occlusion?

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**Key Clinical Message**

Routine venography should be performed before the device upgrade. Clinicians should not be unconcerned because of the lack of symptoms following lead-related venous occlusion. Knowledge of collateral anatomy is essential for future interventional plans. The venous pathway's return to the right atrium may entail risks to patient outcomes.

**KEYWORDS**

collateral pathway, lead-related venous occlusion, pacemaker, venography

## 1 | INTRODUCTION

Lead-related complete venous occlusion after transvenous placement of a cardiac device occurs in the axilla-subclavian segments in up to 26% of patients.[1] However, it is usually asymptomatic, because of the development of adequate collateral circulation, and is noted as an incidental finding during procedures necessitating implantation of new or additional leads. If an upgrade procedure to cardiac resynchronization therapy (CRT) in a patient with an existing device and worsening heart failure is indicated and ipsilateral venous occlusion is diagnosed, the 2017 HRS expert consensus statement provides a Class IIa recommendation for the removal of noninfected lead(s) as first-line treatment to regain venous access in an individualized decision-making process based on operator and center expertise.[2] Other interventional management options include balloon venoplasty for recanalization, contralateral side lead implantation with tunneling across to the other side, or even new device implantation through the same access site.[2–4] In contrast, if the venous occlusion has been discovered coincidentally, a conservative approach may be preferred, whereby the benefits of having the lead(s) removed must be weighed against the risk of the extraction procedure.

We report a case of previously unsuspected total occlusion of the left brachio-cephalic vein related to ipsilateral pacemaker implantation. As a consequence, an impressive collateral venous circulation was developed capable of diverting the blood flow back to the right atrium through the accessory hemiazygos and azygos venous system. Herein, we discuss the anatomic characteristics, the clinical relevance, and the management options associated with this rare venous formation.

## 2 | CASE HISTORY

A 79-year-old man with worsening heart failure symptoms New York Heart Association class II-III and persistent atrial fibrillation was admitted for "upgrading" permanent right ventricular pacing to CRT. Fifteen years ago, he was implanted with a dual chamber pacemaker (Identity 5386, Abbott Medical, St. Paul, Minnesota) via the left subclavian vein for a high-degree atrioventricular block. Bipolar screw-in leads were placed in the right

atrium (Tendril® Model 1782TC) and the right ventricular mid-septum (IsoFlex® S Model 1646 T). An elective generator replacement for a depleted battery (Endurity 2152, Abbott) was performed 1 year ago. The device was functioning correctly programmed in VVIR mode with a lower rate of 60 bpm. Past medical history included type 2 diabetes, high blood pressure, and chronic kidney disease with serum creatinine levels fluctuating between 2.7 and 3.3 mg/dL. Chronic drug therapy included apixaban 5 mg b.i.d. Preceding this admission, diagnostic work-up included a coronary angiogram that showed mild coronary artery disease.

## 3 | METHODS

Physical examination did not show clinical signs of heart failure or venous thrombosis. Echocardiography demonstrated marked dilatation of the left ventricle and left atrium, a left ventricular ejection function of 30%, moderate mitral and tricuspid regurgitation as well as impaired RV systolic function and moderate pulmonary hypertension, and interventricular dyssynchrony. The 12-lead surface electrocardiogram revealed continuous ventricular pacing with a paced QRS complex duration of 155 ms. Device interrogation confirmed 100% right ventricular pacing due to bradycardic irregular ventricular response. Chest X-ray demonstrated an enlarged heart silhouette and left ventricle, but no other abnormalities.

Under local anesthesia, the left subclavian vein puncture allowed entry into the lumen and blood aspiration. However, the various guide and angioplasty wires could not be advanced through the vein. Contrast venography via the antecubital vein of the left arm revealed in single anterior-posterior plane proximal occlusion of the left brachio-cephalic vein. Ipsilateral blood flow diversion occurred through the descending accessory hemiazygos vein and then the ascending azygos vein forming an impressive U-shaped loop that enabled blood to reach the right atrium via the superior vena cava. The diameters of the accessory hemiazygos and azygos veins ranged from 9.5 to 16.5 mm along their whole length and were connected with enlarged anastomoses (Figure 1). Measurements were performed by a reference standard.

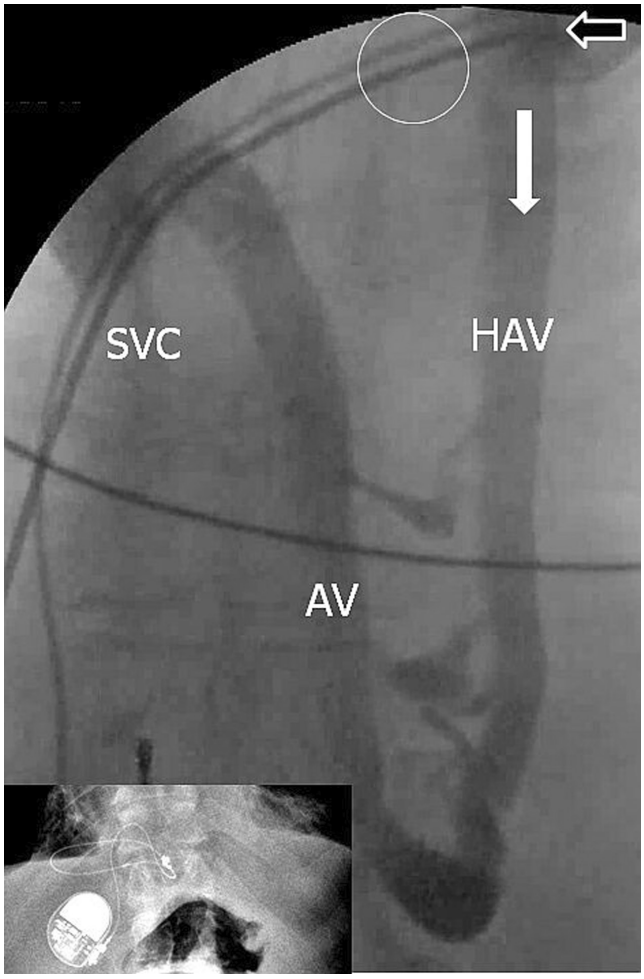


**FIGURE 1** Venography in posteroanterior projection showing proximal occlusion of the left brachio-cephalic vein (white circle) after contrast injection (black arrow). A collateral U-shaped venous pathway maintains blood flow (white arrow) through the accessory hemiazygos vein (descending limb) and the azygos vein (ascending limb) to drain into the superior vena cava. Enlarged anastomoses between AV and HAV. AV, azygos vein; HAV, hemiazygos vein; SVC, superior vena cava. The inset window shows epicardial ventricular lead placement and pacemaker generator implantation in the abdominal wall.

## 4 | RESULTS

Our patient underwent successful transvenous extraction of the pacing leads under temporary ventricular cardiac pacing using the right femoral vein approach in a time-consuming procedure using mechanical rotating dilatator sheaths (TightRail, Spectranetics/Philips; Evolution, Cook Medical). Thereafter, because the pacing-dependent patient did not consent to undergo an upgrade procedure despite detailed explanations, we considered a transition to CRT at a later stage. Meanwhile, a cardio-thoracic surgeon proceeded with epicardial unipolar ventricular lead placement (screw-In Medtronic 5071-35 cm) and pacemaker generator implantation (Vitatron G20A1) in the abdominal wall (Figure 1, inset). No procedure-related complications were encountered. Patient post-discharge follow-up at 3 months, revealed favorable tolerance of right ventricular stimulation and the device's stable parameters. At

present, the patient still refuses to forgo a new CRT procedure or conduction system pacing.

## 5 | DISCUSSION

Decompression of the venous blockage, in this case, occurred through an impressive collateral venous pathway. Our patient was asymptomatic because the venous shunt was able, at first glance, to handle the blood flow. Nevertheless, given that the normal diameter of the azygos vein is approximately 3–9 mm in width, unexpected and disquieting findings were the marked dilatation of the collateral venous formation measuring 9.5–16.5 mm as well as their anastomoses. Even though the patient was asymptomatic because the venous shunt appeared able to handle the blood flow at first glance, the presence of venous dilatation raises concern about the function and adaptability of the collateral system to compensate for increased needs in blood volume and pressure. In this regard, an increased mean right atrium pressure has been suggested as the main reason for the enlargement of the azygos vein.[5] In our patient, fluid overload, heart failure, and pulmonary hypertension could have caused significant blood flow reduction or even stasis. Moreover, given the presence of a hypercoagulable state due to underlying atrial fibrillation and heart failure, the coexistence of the described collateral pathway might create a serious threat of thromboembolic complications. On the other hand, the risk of vein rupture cannot be considered to be negligible, particularly in the case of accompanied anticoagulant therapy. Tailored routine diagnostic screening for lead-related venous occlusion and collateral pathway presence may be considered in the presence of major risk factors such as the existence of multiple or abandoned leads, presence of coronary sinus leads, previous use of transvenous temporary pacemakers, male gender, and reduced left ventricular function.[6,7] In this regard, it is important to note that the presence of collateral pathway after lead replacement or upgrade procedures as well as the procedure of transvenous lead extraction per se, were found to be associated with upper extremity deep venous thrombosis, pulmonary embolism, and worse prognosis.[8,9]

If a device upgrade is indicated and lead-related venous occlusion has been confirmed, practice guideline holds, first of all, percutaneous lead extraction to restore vein patency, as we did. However, our decision to proceed with epicardial lead implantation in this report may sound to most clinicians more than slightly bizarre. In any case, our procedural plan was based on the patient's unwillingness to proceed with CRT implantation, despite our suggestion and encouragement. After all, even though epicardial pacing is undoubtedly inferior to CRT, and nowadays, is of limited clinical use, it has been shown useful as a real alternative antibradycardia pacing safety option of similar efficiency and complications rate compared with endocardial pacing in pacemaker-dependent patients after pacemaker extraction.[10]

This case focused on the presence of an asymptomatic but potentially hazardous giant venous collateral circulation following pacemaker implantation. On the whole, given the relatively high probability of lead-related venous occlusion, the clinician should not be unconcerned because of the lack of symptoms. Knowledge and understanding of the collateral venous anatomy are essential for diagnosis, facilitate future interventional plans, and increase patient safety.

### AUTHOR CONTRIBUTIONS

**Fani Zagkli:** Conceptualization; writing – original draft. **John Chiladakis:** Conceptualization; writing – review and editing.

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None to declare.

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None.

### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

### DATA AVAILABILITY STATEMENT

Data analyzed are included in the published report.

### CONSENT

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

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### REFERENCES

1. Abu-el-haija B, Bhave PD, Campbell DN, et al. Venous stenosis after transvenous lead placement: a study of outcomes and risk factors in 212 consecutive patients. *J Am Heart Assoc*. 2015;4(8):e001878. doi:10.1161/JAHA.115.001878
2. Kusumoto FM, Schoenfeld MH, Wilkoff BL, et al. 2017 HRS expert consensus statement on cardiovascular implantable electronic device lead management and extraction. *Heart Rhythm*. 2017;14(12):e503-e551. doi:10.1016/j.hrthm.2017.09.001
3. Isawa T, Nomura T, Honda T, Yamata K. A "one-step" treatment for symptomatic lead-related venous obstruction using percutaneous lead extraction, venous stenting, and new device implantation. *HeartRhythm Case Rep*. 2024;10(6):394-397. doi:10.1016/j.hrcr.2024.03.004

4. Kasai Y, Shakya S, Yamaura T, Hayakawa N, Miyaji K, Kanda J. Permanent pacemaker implantation in a hemodialysis patient with subclavian vein occlusion using the ballon-target puncture technique. *Clin Case Reports*. 2021;9(5):e04144. doi:10.1002/ccr3.4144
5. Piciucchi S, Barone D, Sanna S, et al. The azygos vein pathway: an overview from anatomical variations to pathological changes. *Insights Imaging*. 2014;5(5):619-628.
6. da Costa SS, Scalabrini Neto A, Costa R, Caldas JG, Martinelli Filho M. Incidence and risk factors of upper extremity deep vein lesions after permanent transvenous pacemaker implant: a 6-month follow-up prospective study. *Pacing Clin Electrophysiol*. 2002;25:1301-1306.
7. Czajkowski M, Jachec W, Polewczyk A, et al. Risk factors for lead-related venous obstruction: a study of 2909 candidates for lead extraction. *J Clin Med*. 2021;10:5158.
8. Albertini CMM, da Silva KR, Lima MF, Leal Filho JMDM, Martinelli Filho M, Costa R. Upper extremity deep venous thrombosis and pulmonary embolism after transvenous lead replacement or upgrade procedures. *Pacing Clin Electrophysiol*. 2020;43(5):495-502.
9. Czajkowski M, Jachec W, Polewczyk A, et al. The influence of lead-related venous obstruction on the complexity and outcomes of transvenous lead extraction. *Int J Environ Res Public Health*. 2021;18(18):9634. doi:10.3390/ijerph18189634
10. Amraoui S, Sohal M, Li A, et al. Comparison of delayed transvenous reimplantation and immediate surgical epicardial approach in pacing-dependent patients undergoing extraction of infected permanent pacemakers. *Heart Rhythm*. 2015;12(6):1209-1215.

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