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SPOTLIGHT

Successful treatment of lead-related superior vena cava syndrome in combination with transvenous lead extraction and venous stenting

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Although superior vena cava (SVC) syndrome in association with cardiac implantable electronic devices (CIED) is a rare complication, its incidence has been increasing. SVC syndrome causes refractory facial, neck, and upper limb edema as well as dyspnea. We experienced a case of transvenous (TV) lead-related SVC syndrome, which was successfully treated using the unique transvenous lead extraction (TLE) technique and endovascular stenting.

A 47-year-old female was referred to our institution for swelling of the face, neck, and both arms beginning 6 months earlier. She underwent patch closure for a ventricular septal defect at 6 months of age, which was complicated by a complete heart block. Subsequently, she underwent implantation of a pacemaker using a TV right ventricular (RV) lead via the right internal jugular vein. However, a TV lead malfunction occurred at 1 year of age. She was observed in a junctional rhythm. At the age of 32 years, she underwent implantation of a TV-DDD pacemaker via the left subclavian vein (SCV) because of heart failure. At 45 years of age, she was diagnosed with lead-related tricuspid stenosis and underwent tricuspid valve replacement. The two RV leads were cut at the level of the SVC, and epicardial leads were implanted into the atrium and ventricle. A chest X-ray revealed that the TV atrial and epicardial ventricular leads were attached to the generator (Figure 1A). Venography confirmed occlusion from the innominate (INN) vein to the SVC with extensive venous collaterals, leading to the diagnosis of TV lead-related SVC syndrome (Figure 1B).

As 3 months of anticoagulation therapy with edoxaban was ineffective, TLE of the TV atrial lead was performed with the patient under general anesthesia to recanalize the INN vein and the SVC. However, the Evolution RL rotational sheath (Cook Medical) did not pass through at the level of the SVC-INN junction (Figure 2A). Therefore, the atrial

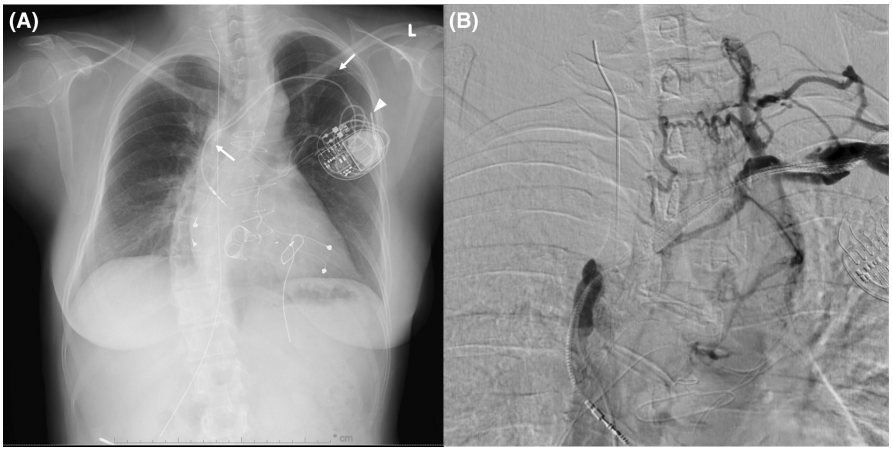

FIGURE 1 (A) Chest X-ray showing that the transvenous (TV) atrial and epicardial ventricular leads are attached to the generator but the epicardial atrial lead is not (arrowhead). A TV right ventricular lead implanted via the left subclavian vein was cut at the proximal and distal ends of the lead (white arrows). (B) Venography from the left subclavian vein and superior vena cava (SVC) demonstrates total occlusion between the innominate vein and SVC with extensive venous collaterals.

lead was caught with a needle's eye snare (Cook Medical) and a 16-Fr femoral sheath. The connector side of the lead was cut short and a 0.014-inch guidewire was inserted into the gap between the outer insulation of the lead and the coil as far as possible. Subsequently, the atrial lead and the tip of the guidewire were extracted from the femoral sheath, which established the rail of the percutaneous venous intervention (Figure 2B, Video SS1).[1] Then 5 mm balloon venoplasty of the occlusion site was performed, and the epicardial atrial and ventricular leads were attached to the generator. The final venography showed favorable dilation from the left SCV to the SVC (Figure 3A). However, her symptoms remained after the procedure although she continued edoxaban and repeat venography 1 week after surgery

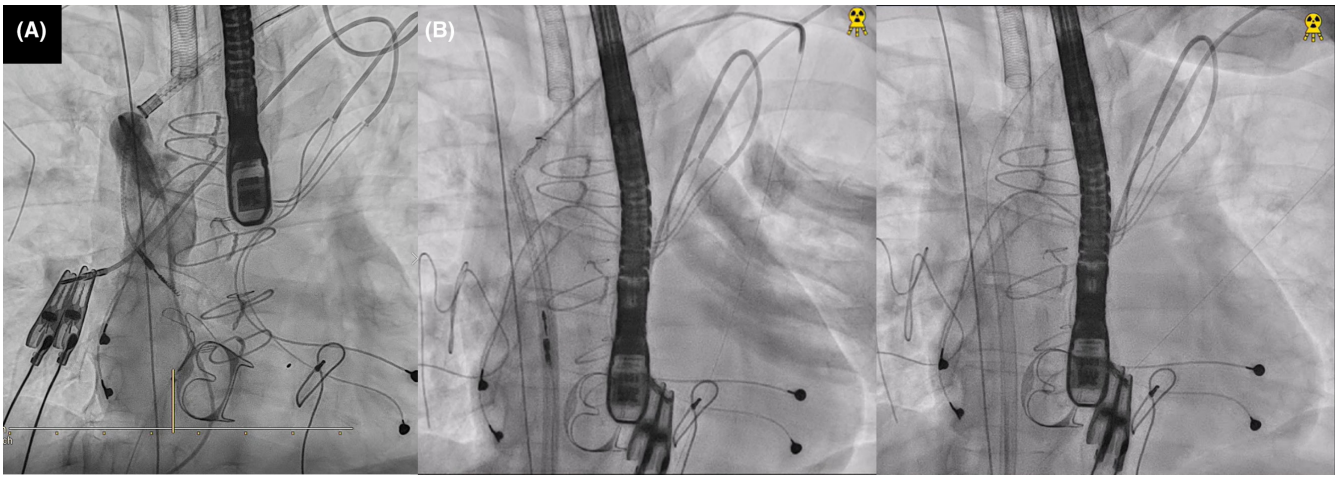

FIGURE 2 (A) Venography from the superior vena cava (SVC) showing that an 11 Fr Evolution RL (Cook Medical) could not pass through the occlusion of the SVC-innominate vein junction due to adhesions. (B) After cutting down the lead, a 0.014-inch guidewire was inserted into the gap between the outer insulation of the lead and the coil as far as possible (*Left panel*). Thereafter, the lead and guidewire were extracted from the femoral sheath using a needle's eye snare (Cook Medical), which allowed the guidewire to pass the occlusion site (*Right panel*).

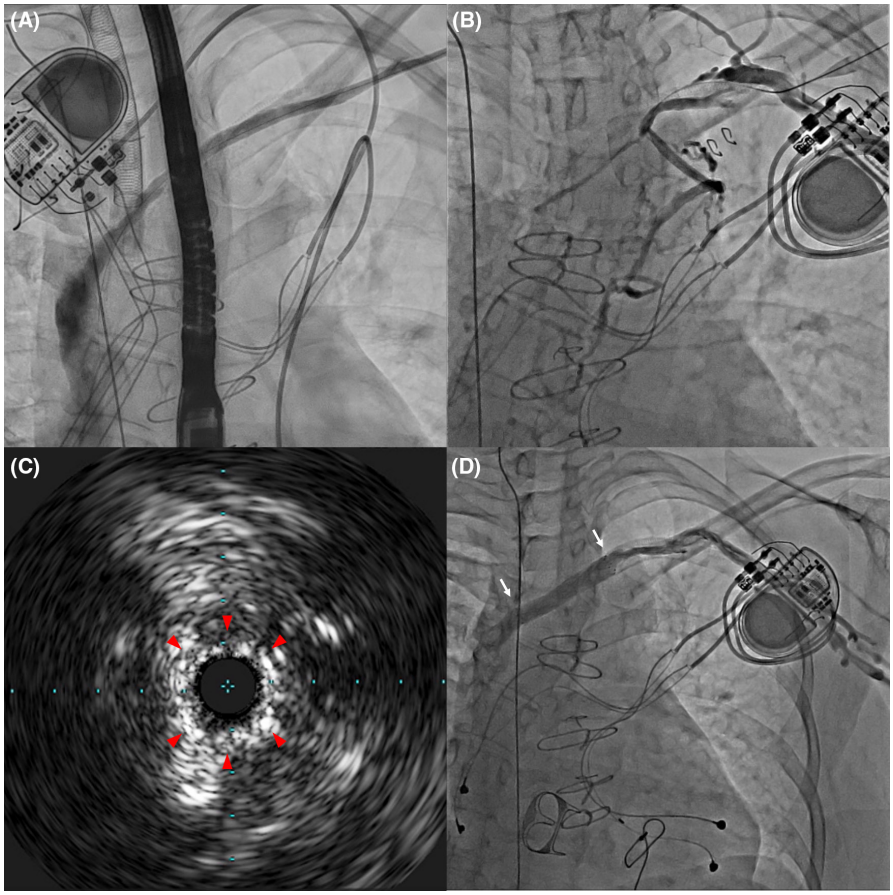

FIGURE 3 Venography was performed during the first session (A) and 1 week later (B). (C) Intravascular ultrasound reveals severe stenosis with circumferential calcification of the vein (arrowheads). (D) Postoperative venography reveals patency from the left subclavian vein to the superior vena cava and regression of the collateral flow. White arrows indicate the proximal and distal edges of the stent.

revealed venous re-occlusion (Figure 3B). Therefore, we performed the second percutaneous venoplasty under intravascular ultrasound (IVUS) guidance. Given the concentric calcifications of the SVC-INN junction apparent in IVUS images (Figure 3C), we considered that elastic recoil was the principal cause of the re-occlusion.[2] Therefore, a nitinol self-expanding stent (SMART; 7.0 mm in diameter, 40 mm in length) was deployed. The final venography confirmed recanalization of the vein. The postoperative course was uneventful and her symptoms improved. The patency of the vein was confirmed by venography 1 week after the procedure (Figure 3D, Video SS2).

Several therapeutic options, including anticoagulation therapy, TLE, venoplasty, stenting, and surgical grafts, can be used to address CIED-related venous obstructions. The JCS/JHRS 2019 guidelines recommended lead extraction for patients with lead-related SVC syndrome, although the evidence is limited.[3] In the present case, we combined TLE with balloon venoplasty during the first session. TLE is safe for penetrating an occluded vein because the TV lead goes through the true lumen of the vein and the TLE instrument tracks the TV lead in the vein. Moreover, it facilitates passing a guidewire through the occluded vein by crossing the guidewire through the TLE sheath after the lead is removed and by inserting the guidewire into the gap of the lead and removing it from the contralateral side, as performed in this case.

A recent study reported that more than half of all patients with SVC syndrome were successfully treated with TLE alone; there was no need for balloon venoplasty or stenting.[4] However, TLE and balloon venoplasty did not maintain venous patency; INN vein re-occlusion was confirmed 1 week after the procedure. Venous stenting under IVUS guidance was successfully performed and produced favorable results. Calcification of the fibrotic adhesions around the TV leads has been reported, particularly after long lead-dwelling times.[5] This case suggests that patients with lead-related chronic venous occlusion and a long lead-dwelling time develop circumferential calcifications around the lead, and venous stenting provides better patency than balloon venoplasty in such cases. IVUS is often used during coronary and peripheral artery interventions and provides information such as vessel size and plaque characteristics. However, little is known about the utility of IVUS during venous interventions because of the small number of patients. This case also suggests that IVUS facilitates decision making on whether the interventionist should perform TLE alone or add venoplasty or stenting in case of a lead-related venous obstruction.

In conclusion, we report the case of SVC syndrome successfully treated with a combination of TLE tools and percutaneous endovascular treatment.

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FUNDING INFORMATION

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CONFLICT OF INTEREST STATEMENT

None.

ETHICS STATEMENT

N/A.

CLINICAL TRIAL REGISTRATION

N/A.

PATIENT CONSENT STATEMENT

Informed consent was obtained from the patient for the publication of this case report.

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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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