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CASE REPORT

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Rare Complications of Pseudoaneurysms of the Superior Vena Cava After Transvenous Lead Extraction

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ABSTRACT

Superior vena cava laceration has been reported as a catastrophic complication that requires immediate surgical intervention during transvenous lead extraction. Hereby, we present 2 cases of pseudoaneurysm formation at the superior vena cava after transvenous lead extraction, which were successfully managed without invasive treatment. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:443-448) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Transvenous lead extraction (TLE) has been used for infected, redundant, or malfunctioning cardiac implantable electronic devices for many years. The incidence of fatal complications after TLE has been reported to be between 0.7% and 1.9%.[1] Although rare, superior vena cava (SVC) laceration is one of the most catastrophic complications, and its mortality rate has been reported to be about 40%.[2] Several cases of SVC laceration with surgical intervention have been reported[3]; however, the following cases demonstrated a rare, related complication of pseudoaneurysm formation at the SVC during TLE. We present 2 cases of SVC pseudoaneurysms that were managed with a conservative strategy.

LEARNING OBJECTIVES

- To understand that pseudoaneurysm formation at the SVC can be seen after TLE.
- To understand that conservative treatment might be a reasonable choice of pseudoaneurysm formation at the SVC after TLE when the patient is in a stable condition.

CASE 1

An 87-year-old male patient who had undergone permanent pacemaker implantation 20 years before cardiovascular implantable electronic device infection was referred for TLE. He underwent coronary artery bypass graft surgery more than 10 years earlier. Silicon-coated right atrial (RA) and right ventricular (RV) passive fixation leads were placed at the time of the original implantation (**Figure 1**). On physical examination, it was noted that the patient's skin on his chest around the pocket of the infected pacemaker was swollen and red. His blood tests showed a slightly elevated C-reactive protein and normal white blood cell count. He was started on teicoplanin and then switched to ampicillin-sulbactam. Based on computed tomography (CT) findings before TLE, both leads were diffusely adherent to the anterior and lateral walls of the SVC (**Figures 2A and 2B,** Video 1).

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

CT = computed tomography

RA = right atrial

RV = right ventricular

SVC = superior vena cava

TLE = transvenous lead extraction

The lead extraction was performed in a hybrid operating room with cardiothoracic surgeons present. The infected generator and the exposed inserting portion of the leads were removed. After inserting a locking stylet (LLD EZ, Spectranetics) into the leads, 14-F and 16-F Excimer laser sheaths (SLS II, Spectranetics) were used to extract the leads. The RA lead was easily removed with the 16-F laser sheath. During the removal of the RV lead, the 16-F laser sheath tended to shave the greater curvature of the SVC (Video 2); however, the leads were completely extracted without any signs of complication at the procedure.

One day after the operation, a chest radiograph revealed a shadow-like at the right mediastinum (**Figure 3**). Contrast-enhanced CT demonstrated an SVC aneurysm surrounded by hematoma without extravasation (**Figures 4A and 4B,** Video 3). No further cardiac interventions were planned after discussing with cardiac surgeons because of stable vital signs without any symptoms. Five days after the TLE, follow-up imaging tests showed significant reduction of the SVC aneurysm. Fortunately, all the lead cultures, wound cultures, and blood culture were negative. Therefore, a new pacemaker was implanted via the right subclavian vein 20 days after TLE. The follow-up CT at 2 months showed improvement of the SVC aneurysm (**Figures 5, 6A, and 6B,** Video 4).

CASE 2

An 81-year-old man who had a 17-year-old pacing system was referred for TLE because of malfunctioning leads. Silicon-coated passive fixation RA and RV leads were used (**Figures 7, 8A, and 8B**).

The lead extraction was performed in the cardiac catheterization laboratory. As in the first case, preoperative CT scanning revealed significant adherence of both leads to the greater curvature of the SVC (Video 5). With a locking stylet (LLD EZ; Spectranetics), the RA lead was successfully removed using a 14-F laser sheath followed by 13-F Evolution (Cook Medical) sheath. Extraction of the RV lead was labored, with 14- and 16-F laser and 13-F Evolution sheaths meeting numerous stopping points in the SVC (Video 6). Although a supportive femoral approach with a snare catheter (OSYPKA) was

FIGURE 1 Preoperative Chest Radiograph of Case 1

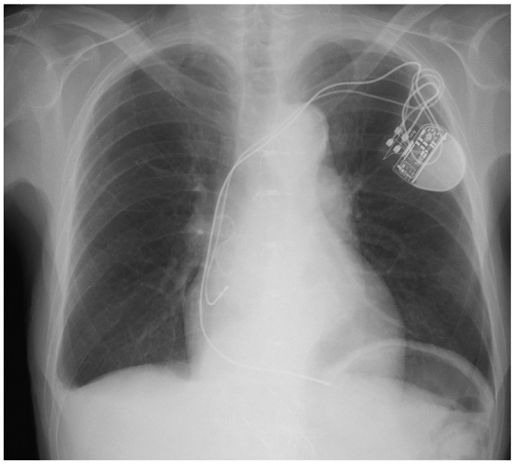
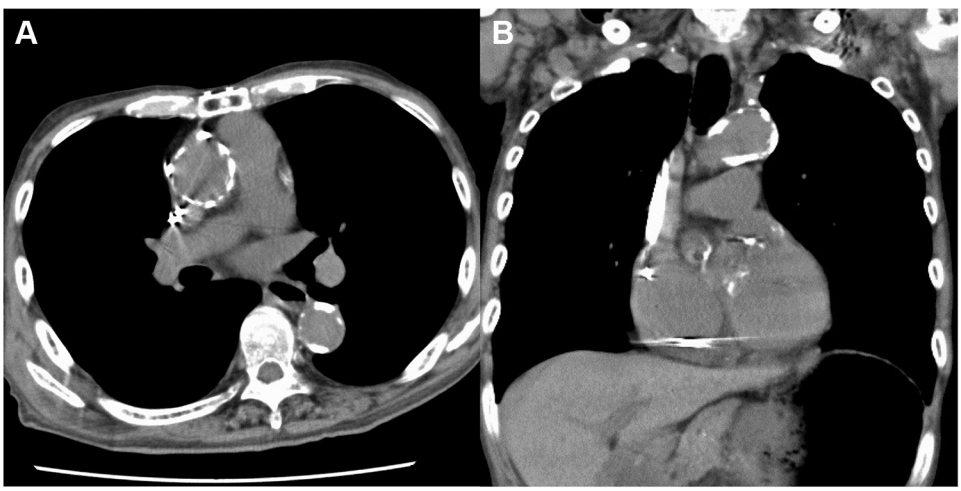
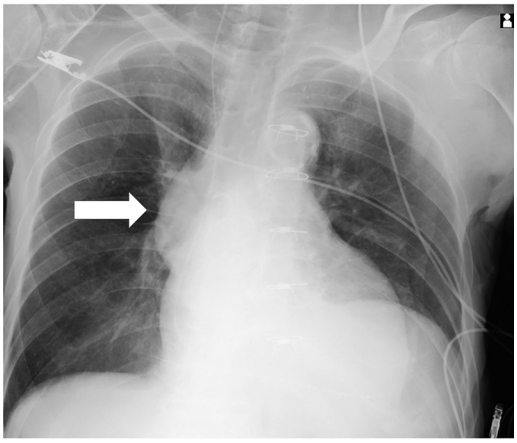


FIGURE 2 Preoperative Chest Computed Tomography of Case 1



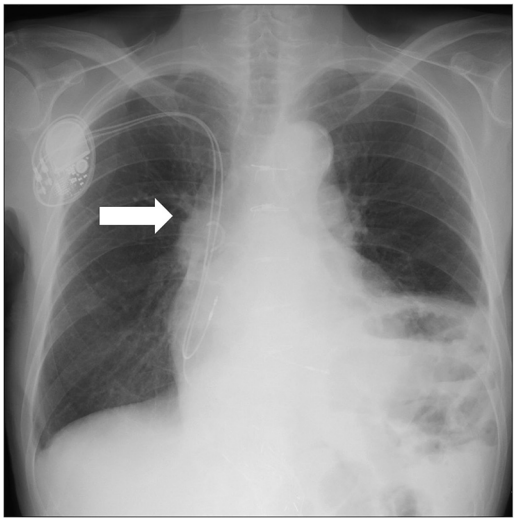
(A) Axial view. **(B)** Coronal view.

FIGURE 3 Chest Radiograph 1 Day After the Operation



The **white arrow** implies an enlarged superior vena cava.

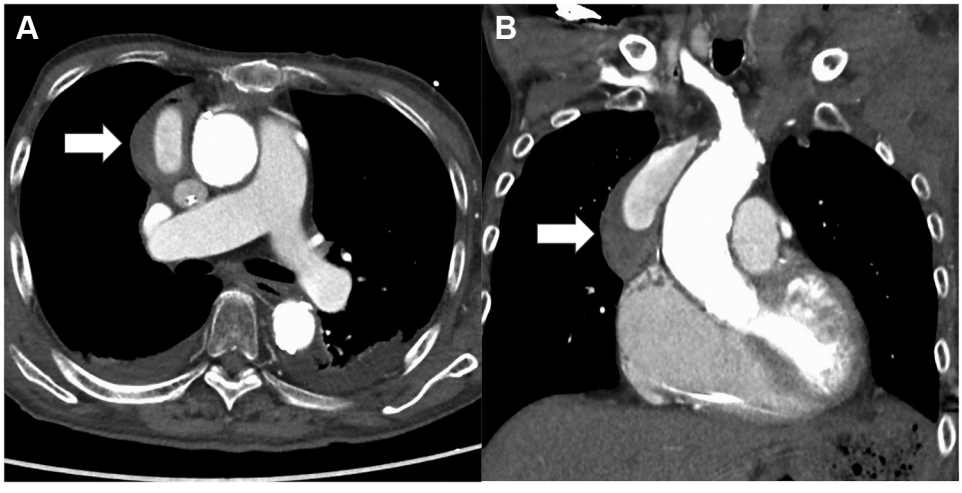
FIGURE 5 Chest Radiograph 2 Months After the Operation



The **white arrow** implies a shrinking pseudoaneurysm.

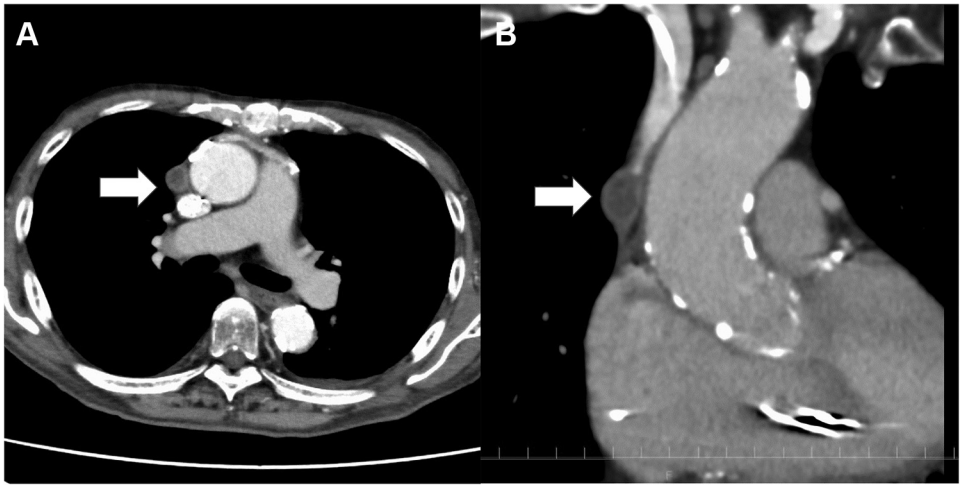
performed, the RV lead was broken (Video 7). As the patient's blood pressure gradually decreased, a diagnostic angiogram of the SVC was performed to identify SVC injury; however, a pseudoaneurysm of the SVC without any extravasation was observed (Video 8). Although balloon occlusion or covered stent placement were discussed, we chose conservative treatment because the internal pressure of the SVC was very low and there might have been a risk of SVC rupture with balloon occlusion or implantation of a covered stent. For these reasons, the TLE procedure was terminated. CT after the TLE also demonstrated pseudoaneurysm of the SVC (**Figures 9A and 9B,** Video 9). Fortunately, 3 months after the procedure, a CT confirmed improvement of the pseudoaneurysm (**Figures 10A and 10B,** Video 10).

FIGURE 4 Chest Computed Tomography 1 Day After the Operation



(A) Axial view. A white arrow shows superior vena cava pseudoaneurysm formation. **(B)** Coronal view. The **white arrows** imply superior vena cava pseudoaneurysm formation.

FIGURE 6 Chest Computed Tomography 2 Months After the Operation



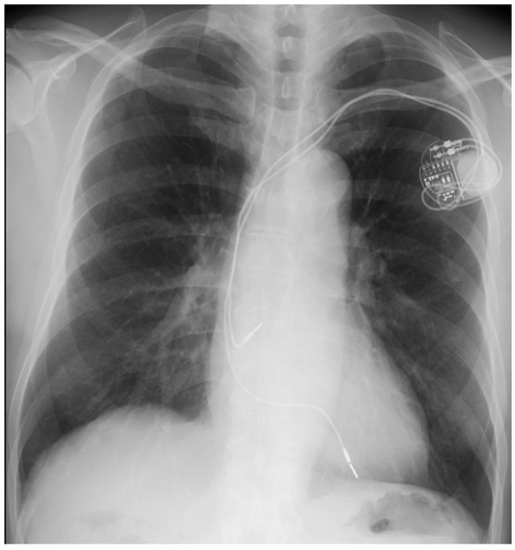
(A) Axial view. **(B)** Coronal view. The **white arrows** show the pseudoaneurysm had shrunk.

DISCUSSION

Although these 2 cases had rare complications of pseudoaneurysms of the SVC after TLE, both patients were discharged in good condition after the events without further intervention.

Although there are no other reports of pseudoaneurysms of the SVC after TLE, there was a case after cardiac surgery.[4] In this report, conservative treatment led to a good prognosis. In another case, a pseudoaneurysm of the inferior vena cava was reported after trauma. The pseudoaneurysm shrank without any interventional treatment in this case.[5]

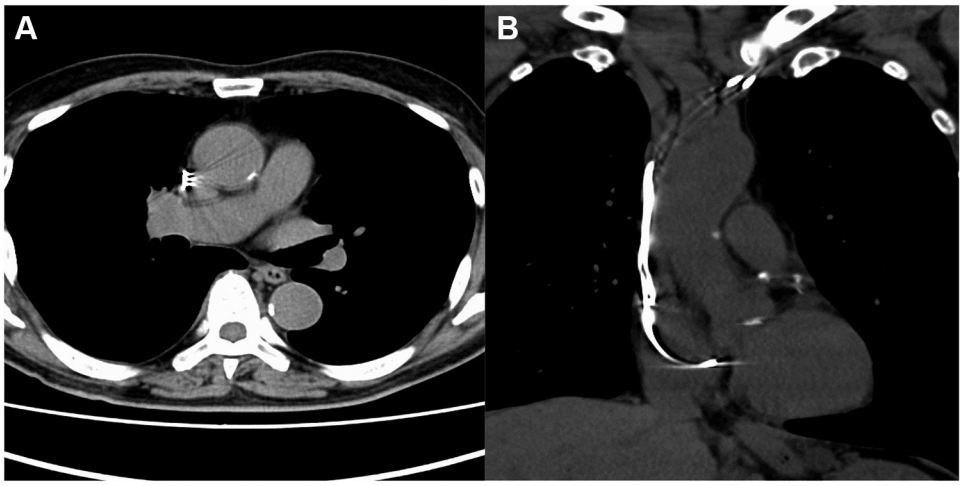
FIGURE 7 Preoperative Chest Radiograph of Case 2



The main mechanism of shrinking pseudoaneurysm of the SVC or inferior vena cava might be low internal pressure of the venous system in comparison with the arterial system. Venous aneurysms are rarely seen in general practice. Based on our cases, venous pseudoaneurysm might confer a good prognosis with conservative treatment. Another possible cause of pseudoaneurysm in the first case that we described is the patient's history of coronary artery bypass graft surgery, which had caused adhesions of pleura or mediastinal tissue. Under this situation, when the SVC is injured by a laser sheath, blood might not travel into the thoracic cavity. Although SVC injury with unstable vital condition definitely requires surgical intervention, SVC aneurysm with stable vital signs may be better managed with a conservative strategy than emergent surgery.

Needless to say, the proper time for the follow-up of imaging of the pseudoaneurysm is soon after lead extraction. SVC rupture after SVC aneurysm has rarely been reported; however, if the pseudoaneurysm ruptures, the risk of sudden death is extremely high. It is necessary to perform a CT when the SVC damage is suspected by radiograph, and it is desirable to perform a CT before discharge to evaluate whether it has grown. It is best practice to follow up on the patient after a few months to ensure that the pseudoaneurysm is shrinking.

FIGURE 8 **Preoperative Chest Computed Tomography of Case 2**

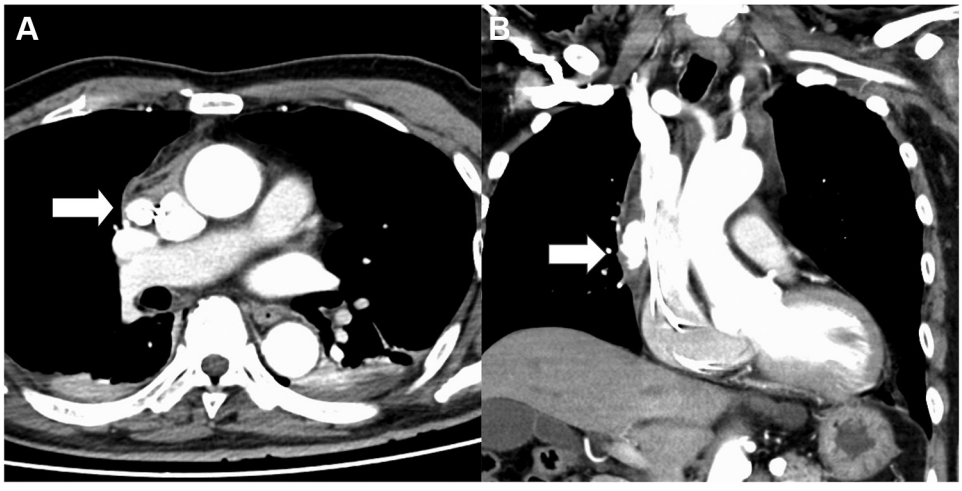


(A) Axial view. **(B)** Coronal view.

The necessity of CT before the lead extraction is still controversial. Our team routinely performs a chest CT for all patients before lead extraction. We believe that patients with the risk factors of complications should undergo CT imaging to allow for a risk-benefit analysis of the procedure. From a report published in *Heart Rhythm*,[6] the number of leads extracted and the presence of dual-coil implantable cardioverter-defibrillator could be predictors of lead extraction procedural complications and longer-term mortality. As one of the methods to reduce risk during the procedure, it is important to prevent the lead from going outside of the SVC by pulling from the femoral vein using a snare catheter.

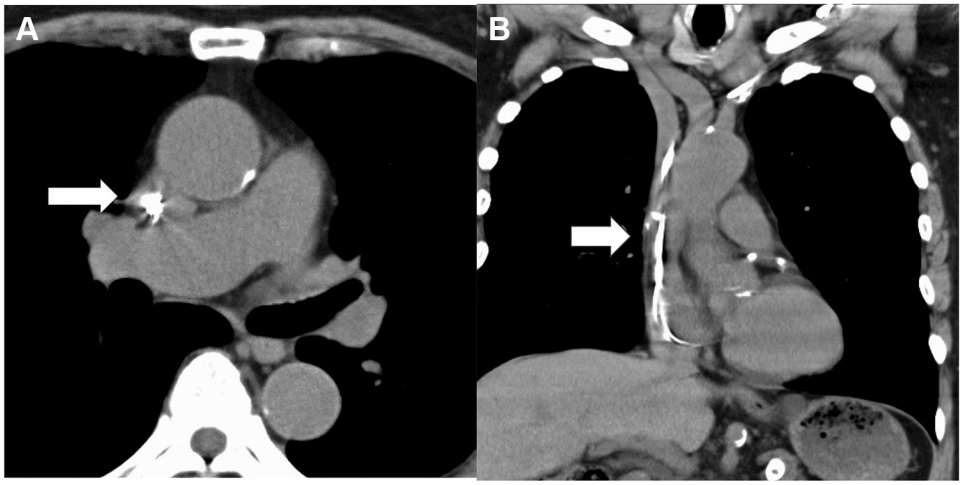
Finally, needless to say, in cases in which the risk of SVC injury is high, preoperative discussion with the anesthesiology and cardiac surgery departments is recommended.

FIGURE 9 **Chest Computed Tomography After Lead Extraction**



(A) Axial view. **(B)** Coronal view. The **white arrows** imply superior vena cava pseudoaneurysm formation.

FIGURE 10 Chest Computed Tomography 3 Months After the Operation



(A) Axial view. **(B)** Coronal view. The **white arrows** show pseudoaneurysm had shrunk.

CONCLUSIONS

We had 2 cases of pseudoaneurysm formation at the SVC after TLE, and the patients were successfully managed with a conservative strategy. Although pseudoaneurysms of the SVC might be rare, they also may be underdiagnosed. Further data on this complication are needed to understand the optimal management and prognosis.

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KEY WORDS complication, lead extraction, superior vena cava laceration

APPENDIX For supplemental videos, please see the online version of this paper.