Implantation of a Totally Implantable Venous Access Device in a Patient with Bilateral Superior Vena Cava: A Case Report

Xianrong Kong[1,2], Wenyan Zhang[1,2]*

[1]*Department of Radiology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China*

[2]*Department of Nursing, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China*

***Correspondence:** Wenyan Zhang, Department of Radiology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, 430030, China

398838421@qq.com

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AUTHORS' CONTRIBUTIONS

X.K.: Clinical management, patient follow-up, imaging analysis, figure preparation, manuscript drafting, data collection and curation.
W.Z.: Conceptualization, procedure performance, manuscript editing, manuscript review. All authors read and approved the final manuscript.

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DISCLOSURES

The authors declare no conflicts of interest or financial disclosures related to this work.

CONSENT

Yes

HUMAN AND ANIMAL RIGHTS

All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1975 Helsinki declaration and its later amendments.

ABSTRACT

Bilateral superior vena cava (BSVC) is a rare congenital venous anomaly, often asymptomatic and discovered incidentally during invasive procedures. We present a 43-year-old woman with right breast cancer (BI-RADS 5) who underwent implantation of a totally implantable venous access device (TIVAD) via the left internal jugular vein approach under digital subtraction angiography (DSA) guidance. Intraoperatively, a persistent left superior vena cava (PLSVC) forming a BSVC was identified. Catheter placement was successfully completed with the tip positioned at the level of the 7th posterior rib, confirmed by DSA and post-procedural CT. This case highlights that a left-sided approach in breast cancer patients may unveil an occult BSVC. DSA-guided bilateral venography and precise catheter tip positioning are crucial for safe TIVAD implantation in patients with this anatomical variation. Our report provides a practical reference for managing similar cases.

CASE REPORT

BACKGROUND

Bilateral superior vena cava (BSVC), most commonly resulting from a persistent left superior vena cava (PLSVC), is a rare congenital venous anomaly with an estimated prevalence of 0.3–0.5% in the general population. While often asymptomatic and discovered incidentally, its presence carries significant implications for central venous access procedures, such as the implantation of totally implantable venous access ports (TIVADs). In patients with unilateral breast cancer, standard guidelines recommend avoiding venous access on the affected side to reduce the risk of complications related to surgery or radiotherapy. This frequently leads to the selection of a left-sided approach, which may unexpectedly reveal an occult PLSVC/BSVC. Navigating this anatomical variant requires precise intraoperative recognition and adaptation of standard technique to avoid serious risks, such as catheter malposition into the coronary sinus, which can precipitate arrhythmias or thrombosis. Current literature contains limited detailed descriptions of a systematic, image-guided protocol for TIVAD implantation in patients with BSVC, particularly within the specific context of breast cancer management. This case report contributes to the literature by providing a comprehensive, step-by-step account of the successful management of such a scenario. It highlights the critical importance of intraoperative vigilance, the utility of contralateral venography for definitive diagnosis, and the imperative for image-guided catheter tip positioning to ensure procedural safety and efficacy, thereby offering a valuable clinical reference for interventional radiologists and oncologic surgeons encountering this rare anatomical condition.

CASE REPORT

A 43-year-old woman was admitted after a screening mammogram revealed an irregular mass in the upper inner quadrant of the right breast. She was otherwise healthy with no significant past medical history. Physical examination confirmed a hard, irregular, non-tender mass measuring approximately 2.5 x 2.0 cm. Breast MRI confirmed a suspicious mass (22 x 20 mm), categorized as BI-RADS 5, leading to a diagnosis of right breast carcinoma. Preoperative laboratory tests were within normal limits.

Imaging Findings

Given the diagnosis of right breast cancer and in accordance with guidelines recommending avoidance of the affected side for central venous access [1,2], a left internal jugular vein approach was selected for totally implantable venous access device (TIVAD) implantation. Under local anesthesia, the left internal jugular vein was punctured. A guidewire was inserted, and an initial radiograph was obtained using the DSA single-shot mode **(**Figure 1a**)**. The vascular course appeared atypical compared to the expected pathway for left internal jugular access to the superior vena cava (Figure 1b). Subsequently, DSA venography was performed via a power injector (Ultravist 370, 2 mL/s; total 6 mL) (Figure 2a). Both the guidewire and contrast medium were observed descending along the left mediastinal border, revealing an anomalous vascular trajectory suggestive of a persistent left superior vena cava (PLSVC).

To delineate the venous anatomy definitively, contrast was administered through a 22G intravenous catheter placed in the right antecubital vein (Ultravist 370, 3 mL/s; total 12 mL). This right-sided venography **(**Figure 2b**)** demonstrated a normal right superior vena cava. Integration of the bilateral venographic images (Figures 2a,2b) confirmed the diagnosis of bilateral superior vena cava (BSVC), with the left-sided vessel (PLSVC) draining into the coronary sinus and thence into the right atrium.

Management and Follow-up

A chest wall incision was made at a relatively flat area medial to the intermuscular groove, approximately two fingerbreadths inferior to the left midclavicular line. A subcutaneous pocket of approximately 1 cm in depth was created. Using a tunneler, the catheter was guided from the cervical incision to the chest wall incision, ensuring the tunneling path avoided acute angles. The catheter length was adjusted based on the intraoperative DSA findings, after which it was connected to the port chamber and the incisions were closed. The catheter tip was positioned at the level of the 7th posterior rib, with a total length of 22 cm (Figure 3).

On postoperative day 3, the patient underwent dressing changes as instructed, and the sutures were removed 10 days later. The patient experienced no adverse reactions such as pain at the puncture site, infection, or catheter occlusion, and daily activities were not significantly affected. As the implanted device was a three-way valve port system, the patient was instructed to undergo a port flushing and locking procedure every 90 days during treatment intervals. A non-contrast chest CT performed on August 14, 2025 (Figure 4) confirmed the satisfactory position of the port catheter and reconfirmed the presence of a bilateral superior vena cava (persistent left superior vena cava). At the one-month postoperative follow-up, the port functioned normally, with no issues reported such as infusion difficulty or arrhythmia.

DISCUSSION

Etiology & Demographics

BSVC is the most common congenital venous anomaly among the major veins returning blood to the heart. It is typically characterized by the confluence of the left subclavian and left jugular veins forming a PLSVC, which descends along the left side of the aortic arch and drains into the coronary sinus after passing near the left hilum and left mediastinal border. A communicating branch may exist between the two superior venae cavae. The right superior vena cava usually maintains a normal anatomy (continuing from the right subclavian vein), whereas the left-sided vessel most commonly drains into the coronary sinus or, less frequently, directly into the left atrium. BSVC results from abnormal embryonic venous development. During the 8th week of embryogenesis, failure of the left anterior cardinal vein to regress leads to the persistence of the left superior vena cava (PLSVC), which coexists with the normally developed right superior vena cava, resulting in a double SVC configuration [3].

Most individuals with BSVC are asymptomatic, and the anomaly is often discovered incidentally during imaging or invasive procedures for unrelated reasons. The reported incidence is approximately 0.3%–0.5% in the general population [4,5]. However, the prevalence is significantly higher in patients with congenital heart disease, such as atrial septal defect, ventricular septal defect and aorticcoarctation , reaching up to 12% [6].

Clinical & Imaging Findings

Most patients with isolated BSVC are asymptomatic. The diagnosis is typically made during imaging or procedures involving central veins. On venography or contrast-enhanced CT, a PLSVC is seen descending lateral to the aortic arch and draining into the coronary sinus (as in our case) or, less commonly, directly into the left atrium. Recognizing this anomaly is crucial before central venous catheterization to avoid malposition and complications.

Treatment & Prognosis

For patients requiring long-term venous access like TIVAD, careful pre-procedural planning is essential. When accessing from the left side in a patient with BSVC, the catheter will travel through the PLSVC. The key is to position the catheter

tip proximal to the coronary sinus ostium to prevent arrhythmias or coronary sinus thrombosis [7-10]. DSA guidance allows real-time confirmation of anatomy and tip position. Alternative methods like intracavitary electrocardiography can also be used for tip navigation [11]. With proper technique, TIVAD implantation in BSVC patients is safe and effective.

Differential Diagnoses

The main differential when encountering an abnormal left-sided venous course is an arterial puncture. This can be distinguished by blood color, pressure, blood gas analysis, or ultrasound characteristics (compressibility, Doppler waveform). Other venous anomalies like left superior intercostal vein drainage or anomalous pulmonary venous return are much rarer and have distinct imaging features.

TEACHING POINT

In patients undergoing left-sided central venous access, an anomalous mediastinal course of the guidewire should raise suspicion for a persistent left superior vena cava. Confirmatory bilateral venography is diagnostic. For safe totally implantable venous access port implantation in this setting, precise catheter tip positioning proximal to the coronary sinus under imaging guidance is paramount to avoid cardiac complications.

QUESTIONS

Question 1 What is the main cause of bilateral superior vena cava (BSVC)?

1. Acquired vascular damage from surgery
2. Failure of the left anterior cardinal vein to regress during embryonic development (applies)
3. Venous obstruction due to breast cancer metastasis
4. Chronic hypertension-induced vascular remodeling
5. Post-chemotherapy vascular anomaly

Explanation: The article states, "BSVC results from abnormal embryonic venous development. During the 8th week of embryogenesis, failure of the left anterior cardinal vein to regress leads to the persistence of the left superior vena cava (PLSVC), which coexists with the normally developed right superior vena cava, resulting in a double SVC configuration [3]" [BSVC results from abnormal embryonic venous development. During the 8th week of embryogenesis, failure of the left anterior cardinal vein to regress leads to the persistence of the left superior vena cava (PLSVC), which coexists with the normally developed right superior vena cava, resulting in a double SVC configuration]. Other options are incorrect because BSVC is a congenital anomaly, not caused by acquired factors such as surgery, tumor metastasis, hypertension, or chemotherapy.

Question 2 Why was the left internal jugular vein approach chosen for TIVAD implantation in this patient?

1. It has a lower risk of infection compared to other approaches
2. To avoid the affected side (right breast) as recommended by guidelines (applies)
3. The left internal jugular vein is larger in diameter
4. The patient had a history of right internal jugular vein thrombosis
5. It allows faster catheter placement

Explanation: The article mentions, "Given the diagnosis of right breast cancer and following guidelines to avoid the affected side for central venous access [1, 2], a left internal jugular vein approach was chosen for TIVAD implantation" [Given the diagnosis of right breast cancer and following guidelines to avoid the affected side for central venous access[1, 2], a left internal jugular vein approach was chosen for TIVAD implantation]. This confirms the core reason for selecting the left-sided approach. No evidence in the article supports the other options (lower infection risk, larger diameter, prior thrombosis, or faster placement) as the decision-making basis.

Question 3 Which of the following is a key measure to prevent complications during TIVAD implantation in BSVC patients?

1. Placing the catheter tip directly into the coronary sinus
2. Using a 3Fr catheter for all BSVC patients
3. Precise catheter tip positioning proximal to the coronary sinus under imaging guidance (applies)
4. Avoiding DSA guidance to reduce radiation exposure
5. Implanting the port in the right chest wall

Explanation: The article emphasizes, "the key is to position the catheter tip proximal to the coronary sinus ostium to prevent arrhythmias or coronary sinus thrombosis [7, 8, 9, 10]. DSA guidance allows real-time confirmation of anatomy and tip position" [the key is to position the catheter tip proximal to the coronary sinus ostium to prevent arrhythmias or coronary sinus thrombosis [7, 8, 9, 10]. DSA guidance allows real-time confirmation of anatomy and tip position] and "precise catheter tip positioning proximal to the coronary sinus under imaging guidance is paramount to avoid cardiac complications" [precise catheter tip positioning proximal to the coronary sinus under imaging guidance is paramount to avoid cardiac complications]. Option 1 is incorrect (catheter tip in coronary sinus causes complications); options 2, 4, and 5 are not mentioned as preventive measures in the article.

Question 4 How was the diagnosis of BSVC confirmed in this patient?

1. Preoperative chest X-ray
2. Bilateral venography (left internal jugular vein + right antecubital vein) under DSA (applies)
3. Routine laboratory tests
4. Postoperative mammogram
5. Ultrasonography of the neck veins alone

Explanation: The article details, "Initial DSA venography... revealed an abnormal vascular course... To confirm the anatomy, a contrast injection was performed via a 22G intravenous catheter placed in the right antecubital vein... The combined images confirmed the diagnosis of BSVC" [Initial DSA venography (Figure 1A) performed with a power injector (Ultravist 370, 2 mL/s, total 6 mL) revealed an abnormal vascular course... To

confirm the anatomy, a contrast injection was performed via a 22G intravenous catheter placed in the right antecubital vein (Ultravist 370, 3 mL/s, total 12 mL)... The combined images (Figures 2) confirmed the diagnosis of BSVC]. Other options are incorrect: preoperative chest X-ray, routine labs, mammogram, and isolated neck vein ultrasound did not confirm BSVC.

Question 5 What is the reported incidence of BSVC in the general population?

1. 0.3%-0.5% (applies)
2. 1%-2%
3. 5%-8%
4. 12%
5. 15%-20%

Explanation: The article states, "The reported incidence is approximately 0.3%-0.5% in the general population [4, 5]." [The reported incidence is approximately 0.3%-0.5% in the general population [4, 5]. Option 4 (12%) refers to the incidence in patients with congenital heart disease, not the general population. The other options do not match the reported incidence in the article.

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FIGURES

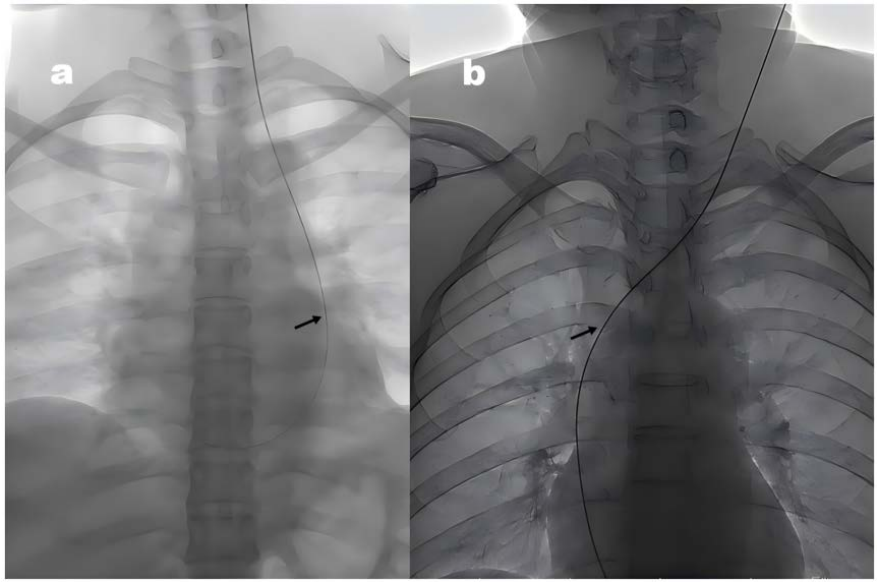

Figure 1: (a) Guidewire (arrow) introduced via the left internal jugular vein courses along the left mediastinal border in the patient with persistent left superior vena cava (PLSVC).

(b) In a patient with normal anatomy, the guidewire (arrow) follows the expected right mediastinal course after left internal jugular vein access.

Abbreviations: PLSVC, persistent left superior vena cava; SVC, superior vena cava.

Figure 2: (a) Left-sided DSA venography (via the persistent left superior vena cava, PLSVC) shows contrast draining into the right atrium through the coronary sinus.

(b) Right-sided DSA venography (via the right antecubital vein) demonstrates contrast opacifying the right superior vena cava (RSVC) before entering the right atrium.

Abbreviations: DSA, Digital Subtraction Angiography; PLSVC, Persistent Left Superior Vena Cava; RSVC, Right Superior Vena Cava.

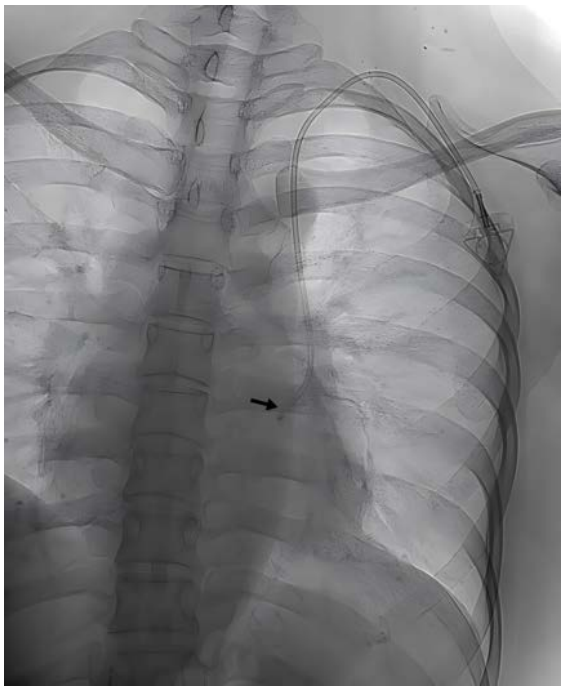

Figure 3: Post-procedural radiograph confirms the catheter tip (arrow) positioned at the level of the 7th posterior rib following venous access port implantation.

Figure 4: Coronal reformatted image from a post-procedural non-contrast chest CT demonstrates bilateral superior venae cavae (white arrow indicates the persistent left superior vena cava).

KEYWORDS

Bilateral superior vena cava; Persistent left superior vena cava; Totally implantable venous access port; Port implantation; Case report

ABBREVIATIONS

BSVC = Bilateral Superior Vena Cava
PLSVC = Persistent Left Superior Vena Cava
RSVC = Right Superior Vena Cava
SVC = Superior Vena Cava
TIVAD = Totally Implantable Venous Access Device
DSA = Digital Subtraction Angiography