Case Report/*Olgu Sunumu*

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Echocardiography-Guided Management of a Dialysis Catheter Complication: A Case Report

Ekokardiyografi Eşliğinde Diyaliz Kateteri Komplikasyonunun Yönetimi: Olgu Sunumu

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ABSTRACT

The right internal jugular vein is the standard route for central venous catheterization. However, anatomical anomalies such as masses may necessitate alternative access. In this case, catheter placement via the left internal jugular vein was required due to compression of the right jugular vein by a thyroid mass. Following insertion, the absence of blood return raised concerns regarding malposition. While chest X-ray and computed tomography were inconclusive in identifying the catheter tip location, definitive confirmation was achieved through echocardiographic evaluation. Transesophageal echocardiography (TEE) with agitated saline accurately revealed extravascular placement within the pleural space. Subsequently, the catheter was safely removed under transthoracic echocardiographic guidance without complications. This case underscores the superior diagnostic accuracy and procedural guidance offered by echocardiography—particularly TEE—over conventional imaging modalities in the detection and management of catheter-related complications.

Keywords: Catheter, central venous catheterization, echocardiography

ÖZ

Sağ internal juguler ven santral venöz kateterizasyon için standart ve rutin bir yoldur. Ancak anatomik anomaliye sebep olan kitle gibi çeşitli durumlar alternatif yol gerekliliğini doğurabilir. Bu vakada; sağ internal juguler ven, tiroid kitlesine bağlı olarak basıya uğradığı için, kateter; sol internal juguler ven kullanılarak yerleştirilmiştir. Yerleşim sonrası kan aspire edilememesi üzerine kateterin yanlış yerleşimli olabileceğini düşündürmüştür. Akciğer grafisi ve bilgisayarlı tomografinin kateter ucunu göstermede başarısız olması sebebiyle ekokardiyografik değerlendirme yapılmıştır. Ajite salin testi uygulanan hasta transözofageal ekokardiyografi (TEE) ile değerlendirilmiş ve kateter ucunun ekstravasküler alanda, plevral boşlukta olduğu gösterilmiştir. Kateter; transtorasik ekokardiyografi eşliğinde komplikasyonsuz bir şekilde çekilmiştir. Bu olgu, kateter ilişkili komplikasyonların saptanması ve yönetiminde, özellikle TEE olmak üzere, ekokardiyografinin konvansiyonel görüntüleme yöntemlerine kıyasla üstün tanısal doğruluk ve işlem yönlendirme kapasitesini ortaya koymaktadır.

Anahtar sözcükler: Kateter, santral venöz kateterizasyon, ekokardiyografi

INTRODUCTION

The most common complications associated with central venous catheterization (CVC) include pneumothorax, venous thrombosis, arterial puncture, and infection (1). Ultrasound-guided CVC is relatively safe, with markedly reduced complication rates. Extraluminal catheter placement is rare and often difficult to detect in its early stages.

While catheterization of the right internal jugular vein (RIJV) is relatively straightforward and is generally considered the first-line approach, the left internal jugular vein (LIJV) is not recommended as the initial route for catheterization (2). However, LIJV access may become necessary in multiple failed cannulation attempts, thrombosis, or infection involving other central veins (3).

Various techniques, including radiography, electrocardiography (ECG), ultrasound (US), and echocardiography, are employed to confirm accurate CVC placement. In our case, transthoracic echocardiography (TTE) and transesophageal

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echocardiography (TEE) were utilized to verify catheter positioning and to guide the management of venous perforation occurring during LIJV catheterization.

CASE PRESENTATION

A 70-year-old female patient presented with signs and symptoms of left lower extremity ischemia. Digital subtraction angiography revealed occlusions in the left external iliac, superficial femoral, and popliteal arteries. The patient subsequently underwent left femoral artery embolectomy followed by a Lisfranc amputation. Given a body mass index greater than 30 kg m^{-2} and challenging peripheral circulation, central venous catheterization (CVC-7 Fr three-lumen 16 cm catheter)) was performed via the LIJV. The RIJV was avoided because of a 67 mm mass in the right paratracheal region compressing the trachea.

Postoperatively, the patient developed signs of septic shock, including severe hypotension, oliguria, metabolic acidosis, and increase in acute phase reactants. As the acute renal failure became more pronounced, a decision was made to initiate hemodialysis. The replacement of the patient's existing LIJV catheter with a hemodialysis catheter (HDC) was the most suitable option for vascular access. Following elective endotracheal intubation, an attempt was made to insert the HDC over a guidewire through the existing CVC; however, failure to advance the guidewire necessitated catheter removal, and a new HDC was subsequently placed in the LIJV under ultrasound guidance using the Seldinger technique.

After catheter placement, one lumen failed to yield blood return. Blood gas analysis from the patent lumen was consistent with venous blood. A posteroanterior chest X-ray (PA-CXR) revealed that the catheter tip was adjacent to the descending thoracic aorta (Figure 1). Computed tomography (CT) imaging showed that while the proximal portion of the catheter was within the LIJV, it had not advanced into the superior vena cava (SVC). The distal tip was close to the descending aorta but not within its lumen. Given the absence of hypotension, tachycardia, or significant hemoglobin drop, emergency surgery was not deemed necessary, and close hemodynamic monitoring was initiated.

Under dexmedetomidine sedation, TEE was performed to confirm the exact catheter position. The mid-esophageal bicaval view confirmed that the catheter tip was not located within the right atrium. An agitated saline contrast study, prepared by rapidly agitating a 10 mL syringe containing 9 mL of 0.9% saline and 1 mL of air, was performed to assess proximal catheter misplacement; however, no microbubbles were observed in the right atrium (RA). A hyperechoic structure—presumed to be the catheter—was identified in the left pleural space. The agitated saline study was repeated, this time with simultaneous TTE imaging of the lung base. Both TEE and TTE visualized microbubbles in the lung base (Figure 2).

It was decided to remove the malpositioned catheter. Before removal, fresh frozen plasma (FFP) were transfused due to elevated international normalized ratio (INR). Baseline pleural effusion was evaluated by TTE, and the catheter was withdrawn under continuous invasive blood pressure monitoring. After retracting approximately 5–6 cm, blood return was noted, and blood gas analysis confirmed the blood was venous in origin. Hemoglobin levels and pleural fluid volume (via TTE) were measured at 30-minute intervals. A slight increase in pleural fluid was observed, with measurements rising from 6.76/1.18 cm to 7.72/1.45 cm across two planes (Figure 3). Hemoglobin dropped from 9.4 g dL^{-1} to 7.6 g dL^{-1} over 3 hours. As no further echocardiographic evidence of hematoma expansion was seen, the hemoglobin drop was attributed to dilution from saline and FFP transfusions dilution. The patient remained hemodynamically stable throughout the follow-up period.

DISCUSSION

Central venous catheterization may result in serious complications, notably pneumothorax, hemothorax, chylothorax, tamponade, infection, hematoma, and vascular or neural injury (3). Pulmonary complications such as pneumothorax and pneumomediastinum are reported in approximately 1–6% of CVC placements—particularly with subclavian access—and result from pleural injury by the needle, guidewire, or dilator. Moreover, catheter malposition has led to unintentional cannulation of diverse anatomical structures including the internal carotid artery, subclavian artery, subclavian vein, azygos vein, thoracic duct, and even the mediastinum (4).

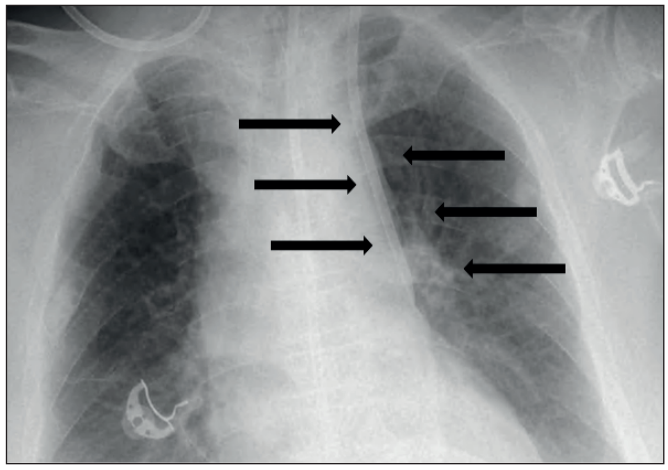

Figure 1. The CVC observed next to the descending thoracic aorta in the posteroanterior chest X-ray.

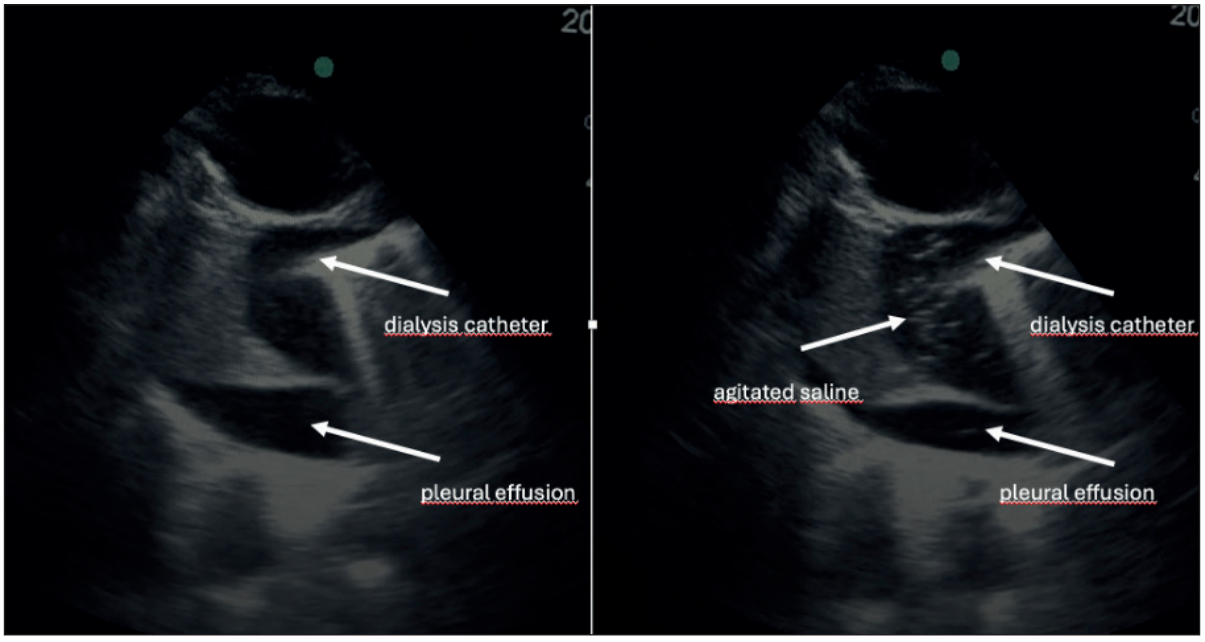

Figure 2. Transthoracic echocardiography microbubble detection in pleural space, consistent with extravascular placement.

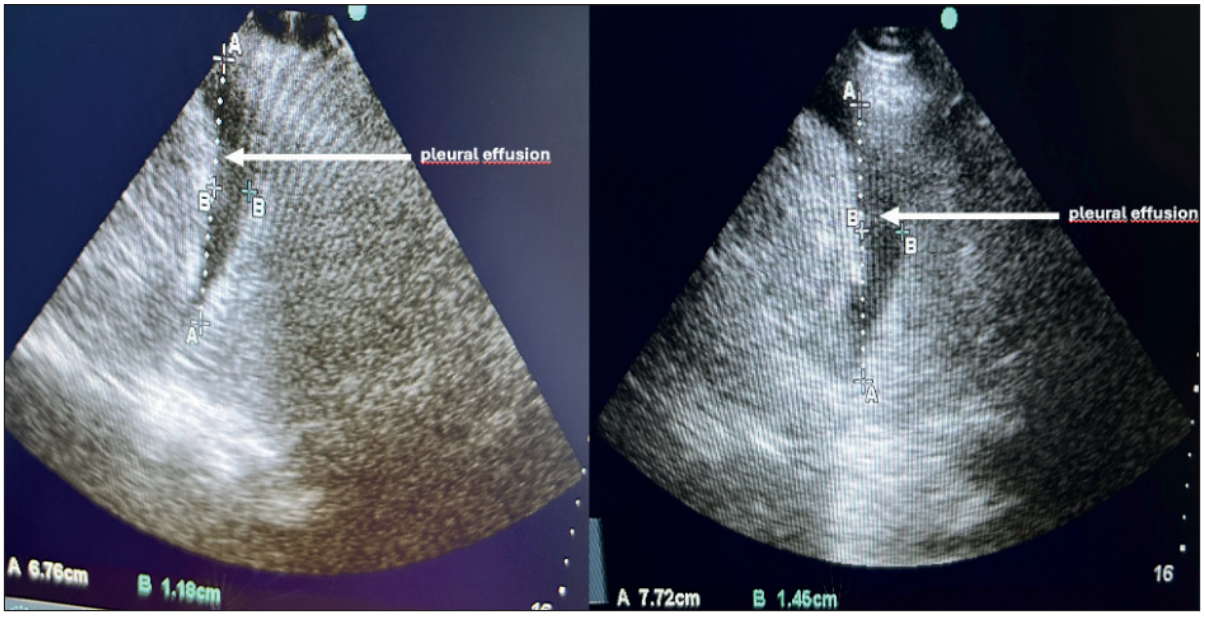

Figure 3. Pleural effusion monitoring with TTE. The measurements increased from 6.76/1.18 cm to 7.72/1.45 cm in two planes.

Verification of catheter tip position is crucial following CVC insertion and is traditionally performed using CXR, ECG guidance, and US. However, CXR is increasingly less favored due to its two-dimensional representation and radiation exposure, especially when bedside alternatives are available. Electrocardiography guided catheter placement offers real-time confirmation via P-wave morphology, reducing malposition and over-insertion. However, its utility diminishes significantly in patients with atrial fibrillation or flutter, or paced rhythms due to absent or altered P-wave morphology (5). Recent studies have described US as an accurate method for confirming catheter placement and preventing life-threatening complications (6). Ultrasonography guidance is valuable for venous puncture; however, its role in verifying catheter tip placement within the SVC is limited. While TTE and TEE visualize the catheter tip at the SVC-right atrium (RA) junction, their accuracy is operator and anatomy-dependent; obesity, for example, may impair TTE penetration (7). The anatomical

difficulties of LIJV catheterization are the angulations at the junctions of the LIJV-subclavian vein and the brachiocephalic vein-SVC. Complication reports confirm that left-sided catheter placement is a significant risk factor (8).

In our case, the CVC was inserted under US guidance. Follow-up chest radiography revealed an atypical trajectory of the catheter within the left mediastinum, raising concern for potential subclavian vein perforation with extravascular migration into the mediastinal space. However, the ability to aspirate blood from one lumen suggested the possibility of either intravascular placement or hemorrhage from a vascular injury into a confined space. Two differential scenarios were therefore considered: 1) the catheter resided within an atypical or aberrant vascular channel, such as a persistent left superior vena cava (PLSVC); 2) it penetrated a major vessel—with aspirated blood originating from a hematoma in the mediastinum. The prevalence of PLSVC is 0.3–0.5% in the general population (9). Technical challenges associated with PLSVC may lead to catheter misplacement and vessel wall injury (10). These anatomical variations have been recognized to predispose to catheter malposition, often manifesting during left-sided access and resulting in atypical catheter trajectories on imaging. A thoracic CT scan was performed to evaluate for PLSVC; this anomaly was not observed. In addition, echocardiography techniques—such as agitated saline injection via the CVC during TEE or TTE—have demonstrated high sensitivity for detecting PLSVC, particularly when contrast flows into the coronary sinus or left atrium. Therefore, to definitively localize the catheter tip, we performed TEE and TEE together with agitated saline. The injected bubbles tracked into the left pleural space rather than the RA, confirming that the catheter had perforated vessel wall. We concluded that the aspirated blood originated from catheter-induced erosion, resulting in a hematoma within the left pleural cavity rather than intravascular placement.

Extravascular placement of a CVC is uncommon but poses a serious risk, with an incidence between 0.17% and 1.14% per catheterization (11). Central venous catheterization-related vascular injury should not be managed by immediate removal; treatment options include surgical repair for active bleeding, endovascular repair with catheter removal, or removal with observation when bleeding is absent (12,13). However, the effectiveness of this approach is uncertain, and if the patient remains symptomatic, endovascular intervention is required.

Management of suspected vascular injury from CVC placement must be individualized based on the patient's coagulation status and the catheter's anatomical position (14). Pre-procedural correction of coagulopathy is often considered to mitigate bleeding risk. However, evidence remains limited and practice varies considerably. For example, it generally recommends evaluating INR, PTT, and platelet counts before catheter removal, with thresholds (INR> 1.5 or platelets < 50×10^9 L^{-1}) serving as criteria to consider plasma or platelet transfusion.

In our patient, due to a substantially elevated INR, we administered two units of FFP before attempting controlled catheter removal. Hemostasis was meticulously monitored via serial hemoglobin measurements and TTE to detect thoracic fluid accumulation. Additionally, surgical and endovascular interventional support was prearranged to address any emergent bleeding complications.

CONCLUSION

Widely used for cardiac evaluation, TEE enables precise CVC confirmation through RA–SVC junction visualization (15). However, due to its semi-invasive nature and requirement for specialized expertise, TEE is not typically regarded a first-line imaging modality. Consistent with the literature demonstrating the superiority of transesophageal echocardiography over conventional ultrasonography and radiography for confirming intravascular guidewire and catheter positioning, agitated saline contrast echocardiography serves as a simple and effective adjunct for accurate central venous catheter tip verification and safe catheter-related management (16).

In the present case, TEE was successfully employed to confirm catheter misplacement in proximity to the left pleural space, enabling accurate diagnosis of an otherwise elusive complication. We recommend considering TEE not only for initial diagnosis and long-term monitoring in patients with suspected catheter malposition based on our findings. To our knowledge, this is the first reported case combining both TTE and TEE modalities to evaluate such a scenario, thereby providing a unique and valuable contribution to the existing medical literature.

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AUTHOR CONTRIBUTIONS

Conception or design of the work: ENY, CO
Data collection: ENY, ST, CO
Data analysis and interpretation: ENY, HY
Drafting the article: ENY, CO, YU
Critical revision of the article: ST, CO, MHZ
The author (EDN, HY, ST, CO, MHZ, YU) reviewed the results and approved the final version of the manuscript.

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