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Wrong Turn at the Renal Vein: Malposition of a Right Femoral Tunneled Hemodialysis Catheter Into the Left Renal Vein

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Abstract

Tunneled hemodialysis catheters placed through the femoral vein provide an alternative form of vascular access when conventional upper-body access is unavailable or undesirable. However, their extended intravascular course may permit clinically important malposition. We describe a 78-year-old man with severe heart failure and chronic kidney disease who developed oligoanuric acute kidney injury after an out-of-hospital cardiac arrest. Hemodialysis was initiated through a temporary left femoral catheter. Because continued dialysis was anticipated and upper-body access was limited by recent cardiac-device procedures, a 44-cm cuffed tunneled dialysis catheter was inserted through the right femoral vein under ultrasound guidance. Both lumens aspirated and flushed normally, and no resistance was encountered during placement. Routine abdominal radiography demonstrated that the catheter ascended the inferior vena cava (IVC) before turning sharply toward the left, with its tip likely terminating in the left renal vein. The catheter was not used and was exchanged over a guidewire for a 42-cm cuffed catheter. Post-exchange radiography demonstrated termination of the replacement catheter in the intrahepatic IVC. The replacement catheter functioned normally during hemodialysis. No hematuria, bleeding, thrombosis, hemoglobin decline, or other catheter-related complication occurred. This case demonstrates that ultrasound-guided venous entry, uncomplicated advancement, and normal aspiration do not confirm appropriate catheter-tip position. Post-placement imaging should be reviewed before a femoral tunneled dialysis catheter is used.

Categories: Radiology, Internal Medicine, Nephrology
Keywords: catheter malposition, femoral vein, hemodialysis, renal vein, tunneled dialysis catheter

Introduction

Tunneled dialysis catheters provide immediate vascular access for patients requiring prolonged hemodialysis when a functioning arteriovenous fistula or graft is unavailable. The right internal jugular vein is generally preferred because of its relatively straight course into the superior vena cava and lower risk of catheter dysfunction. However, femoral access may be necessary when upper-body access is unavailable, contraindicated, or undesirable because of existing cardiac devices, venous obstruction, infection, or recent procedures [1,2].

Femoral tunneled dialysis catheters must be sufficiently long to traverse the iliac venous system and terminate within a large-caliber segment of the inferior vena cava (IVC), permitting adequate extracorporeal blood flow and minimizing recirculation [2,3]. Although ultrasound guidance improves the safety of femoral venipuncture, it does not confirm the complete course of the guidewire or the final catheter-tip position. A catheter may enter an unintended tributary of the IVC despite uncomplicated venous access, absence of resistance during advancement, and satisfactory aspiration from both lumens [2,3].

Mechanical complications remain clinically important following central venous catheterization. In an analysis of 385 catheterization attempts in critically ill adults, Eisen et al. reported a 14% mechanical complication rate, excluding unsuccessful placement, with improper positioning occurring in 14 cases [4]. Malposition of tunneled hemodialysis catheters has been documented in observational studies and individual case reports [5]. Reported unusual trajectories include entry into the hepatic veins and passage of a femoral tunneled dialysis catheter through a patent foramen ovale [6,7]. Femoral catheter entry into the renal venous circulation is exceptionally uncommon but has been described in renal-transplant recipients with altered pelvic vascular anatomy [8,9] and in a patient with native left renal-vein cannulation [10].

We report the radiographic identification of a 44-cm right femoral cuffed tunneled hemodialysis catheter whose tip was likely positioned in the native left renal vein. The catheter remained unused and was successfully exchanged over a guidewire for a 42-cm catheter terminating in the intrahepatic IVC. This case emphasizes that ultrasound-guided venous entry does not establish appropriate catheter-tip position and highlights the importance of reviewing post-placement imaging before a newly inserted femoral dialysis

catheter is used.

Case Presentation

A 78-year-old man was brought to the emergency department after an out-of-hospital cardiac arrest. His cardiac history was notable for nonischemic cardiomyopathy with advanced heart failure with reduced ejection fraction (New York Heart Association class IV; previously documented left ventricular ejection fraction <20%), chronic atrial fibrillation treated with apixaban, and nonobstructive coronary artery disease. He had a Boston Scientific biventricular implantable cardioverter-defibrillator (CRT-D) and was pacing-dependent. His additional comorbidities included chronic kidney disease, type 2 diabetes mellitus, hypertension, hyperlipidemia, and hypothyroidism.

According to his family, the patient developed acute shortness of breath and subsequently became unresponsive. Emergency medical services found him pulseless in a nonshockable rhythm and initiated cardiopulmonary resuscitation. He was intubated and received four doses of epinephrine before return of spontaneous circulation was achieved.

Shortly after arrival at the emergency department, he experienced another pulseless electrical activity arrest. Cardiopulmonary resuscitation was performed for approximately eight minutes before return of spontaneous circulation was again achieved. His initial electrocardiogram demonstrated wide-complex tachycardia without diagnostic ST-segment elevation (Figure *1*). Bedside cardiac ultrasonography suggested right ventricular dilation (Figures *2*-*3*). Because massive pulmonary embolism was suspected, he received 100 mg of systemic alteplase. Subsequent computed tomography pulmonary angiography showed no pulmonary embolism.

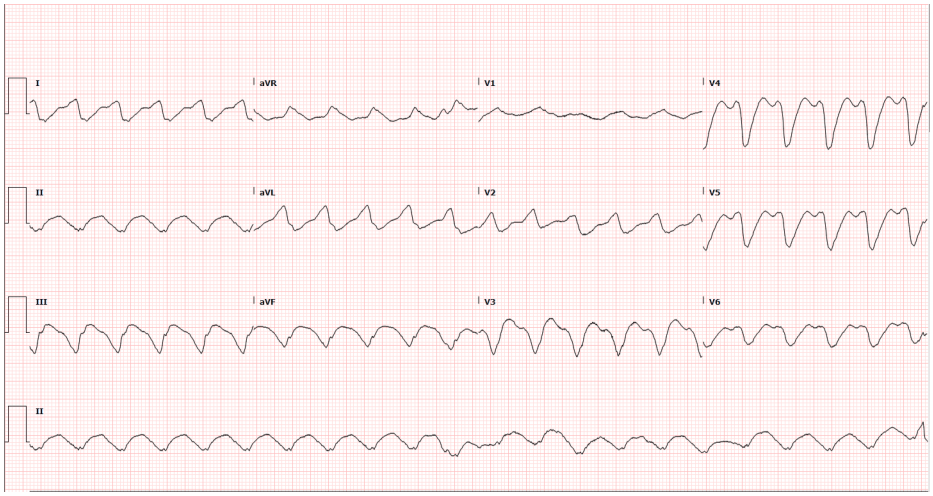


FIGURE 1: Initial 12-lead electrocardiogram obtained after return of spontaneous circulation, demonstrating a regular wide-complex tachycardia at approximately 129 beats/minute.

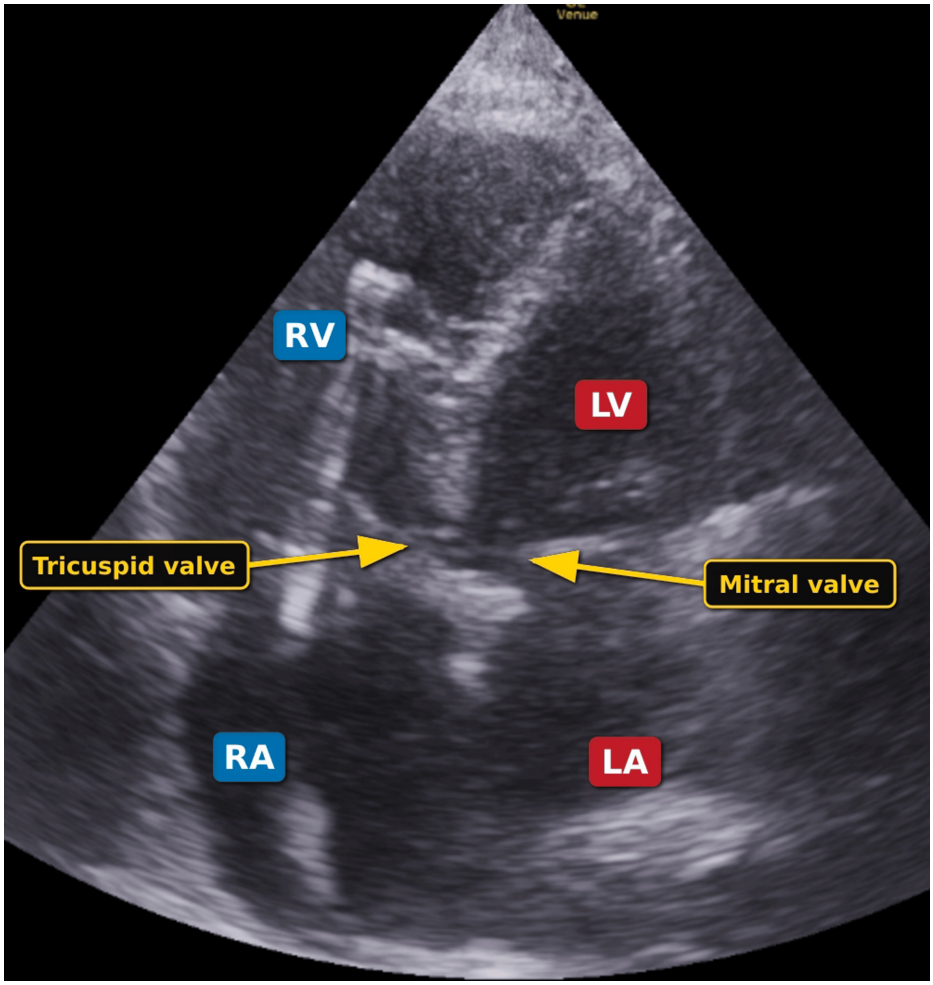


FIGURE 2: Right ventricular dilation on apical four-chamber ultrasonography.

Bedside cardiac ultrasonography in the apical four-chamber view demonstrating right ventricular dilation and a pacemaker within the right ventricle (RV). The left ventricle (LV), right atrium (RA), left atrium (LA), tricuspid valve, and mitral valve are labeled for anatomical orientation.

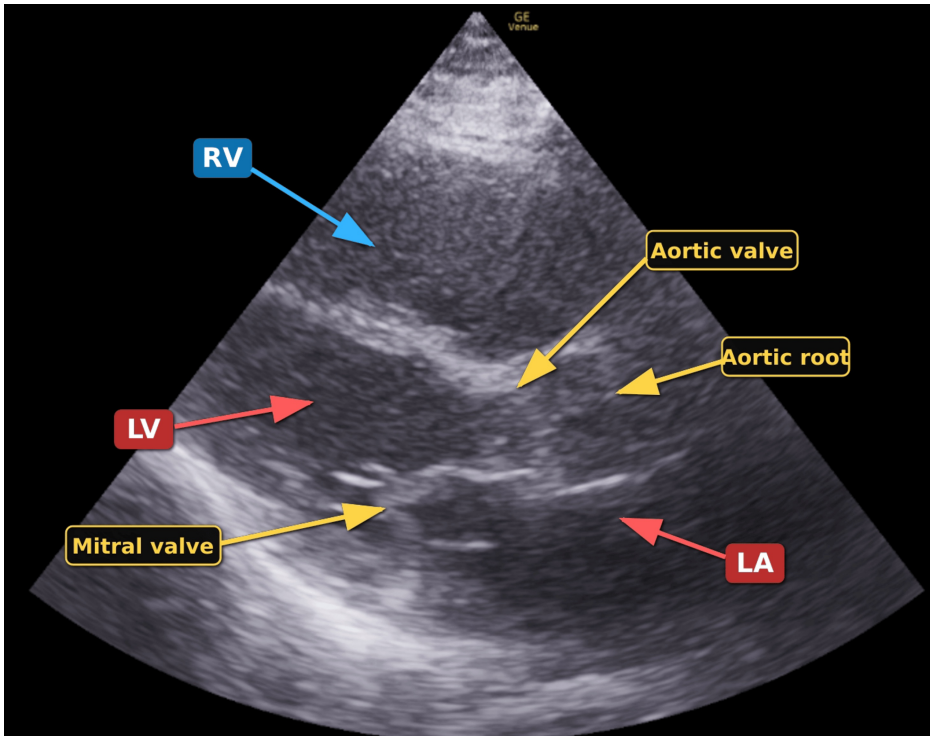


FIGURE 3: Right ventricular dilation on parasternal long-axis cardiac ultrasonography.

Bedside cardiac ultrasonography in the parasternal long-axis view demonstrating the right ventricle (RV), left ventricle (LV), left atrium (LA), aortic root, aortic valve, and mitral valve.

The patient remained mechanically ventilated and became hypotensive, requiring norepinephrine through a right femoral triple-lumen central venous catheter. Initial arterial blood gas analysis demonstrated severe lactic metabolic acidosis, with a pH of 7.15 (Table *1*), a partial pressure of carbon dioxide of 39 mm Hg, a bicarbonate level of 13.6 mmol/L, and a lactate level of 10.3 mmol/L. Initial laboratory testing showed a blood urea nitrogen level of 28 mg/dL, creatinine of 2.6 mg/dL, hemoglobin of 11.9 g/dL, B-type natriuretic peptide of 742 pg/mL, and high-sensitivity troponin of 41 ng/L. He was admitted to the intensive care unit for post-cardiac arrest care.

Parameter	Patient value	Reference range
Arterial pH	7.15	7.36-7.44
Partial pressure of carbon dioxide	39 mmHg	36-44 mmHg
Partial pressure of oxygen	379 mmHg	80-100 mmHg
Arterial bicarbonate	13.6 mmol/L	22-26 mmol/L
Lactate	10.3 mmol/L	0.5-1.3 mmol/L
White blood cell count	6.9 × 10^3/μL	4.5-11.0 × 10^3/μL
Hemoglobin	11.9 g/dL	13.5-17.5 g/dL
Sodium	140 mmol/L	135-145 mmol/L
Potassium	4.7 mmol/L	3.5-5.0 mmol/L
Serum bicarbonate	19 mmol/L	21-31 mmol/L
Blood urea nitrogen	28 mg/dL	7-23 mg/dL
Creatinine	2.6 mg/dL	0.6-1.3 mg/dL
Aspartate aminotransferase	86 U/L	13-39 U/L
B-type natriuretic peptide	742 pg/mL	1-100 pg/mL
High-sensitivity troponin	41 ng/L	3-23 ng/L

TABLE 1: Initial laboratory investigations.

During his intensive care unit course, the patient developed progressive renal dysfunction and oligoanuric acute kidney injury requiring renal replacement therapy. A temporary left femoral trialysis catheter was placed, and intermittent hemodialysis was initiated the following day. His hemodynamic status subsequently improved, norepinephrine was discontinued, and the right femoral triple-lumen catheter was removed after four days.

Because continued hemodialysis was anticipated, tunneled dialysis access was requested. The patient had a newly implanted right-sided Boston Scientific biventricular implantable CRT-D and had recently undergone removal of a left-sided cardiac device. To avoid both the newly implanted right-sided device and the recently instrumented left-sided device site, femoral access was selected. Because a temporary dialysis catheter was already present in the left femoral vein, the right femoral vein was selected for tunneled catheter placement. Preprocedural ultrasonography demonstrated a large-caliber right femoral vein without visible intraluminal echogenic material.

Under maximal sterile precautions and local anesthesia, the right femoral vein was accessed with a 21-gauge needle under real-time ultrasonographic guidance, with the needle tip visualized in the center of the vein. The guidewire was advanced to 20 cm, and ultrasonography confirmed its intravascular position at the femoral access site. Beyond the access site, its trajectory was assessed indirectly by smooth advancement without resistance. A 44-cm cuffed tunneled dialysis catheter was then inserted using the Seldinger technique. The guidewire, dilators, introducer, and catheter advanced without resistance. Intraprocedural fluoroscopy was not used because the catheter was inserted at the bedside using the institution's routine ultrasound-guided technique. Both catheter lumens demonstrated satisfactory blood aspiration and were flushed with heparin. No immediate procedural complication occurred. A postprocedure abdominal radiograph was obtained to determine the final catheter-tip position.

The radiograph demonstrated that the right femoral tunneled dialysis catheter ascended along the expected course of the IVC before turning sharply toward the left mid-abdomen at approximately the renal hilar level. The catheter tip was interpreted as likely terminating in the left renal vein (Figure *4*). A separate temporary left femoral dialysis catheter was visible, with its tip projecting near the left common iliac vein and IVC bifurcation.

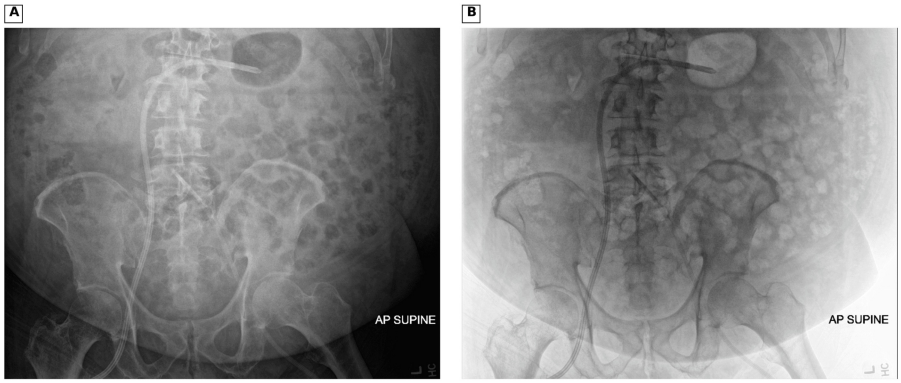


FIGURE 4: Malpositioned right femoral tunneled dialysis catheter.

Panel A: Anteroposterior (AP) radiograph shows a dialysis catheter inserted via the right lower extremity. The catheter tip is directed toward the left mid-abdomen and is likely located in the left renal vein. A separate catheter inserted via the left lower extremity is also visible, with its tip just to the right of the midline at L5. Panel B: The same findings are shown with grayscale inversion.

The malpositioned tunneled catheter was not used for hemodialysis. Approximately two days after placement, the vascular access team exchanged it through the existing right femoral access tract, thereby avoiding an additional venipuncture and tunnel. After the catheter cuff was freed by blunt dissection, a 0.035-inch guidewire was advanced through the existing catheter to 40 cm. The original 44-cm catheter was removed, and a shorter 42-cm cuffed tunneled dialysis catheter was advanced over the guidewire. An intracavitary ECG guidance wire was used to assess catheter-tip position. Both lumens demonstrated satisfactory blood aspiration and flushing, and no immediate procedural complication occurred.

Post-exchange abdominal radiography demonstrated the replacement catheter's appropriate vertical course, with its tip terminating in the intrahepatic IVC (Figure *5*). The temporary left femoral catheter remained visible, with its tip at the left common iliac vein near the IVC bifurcation.

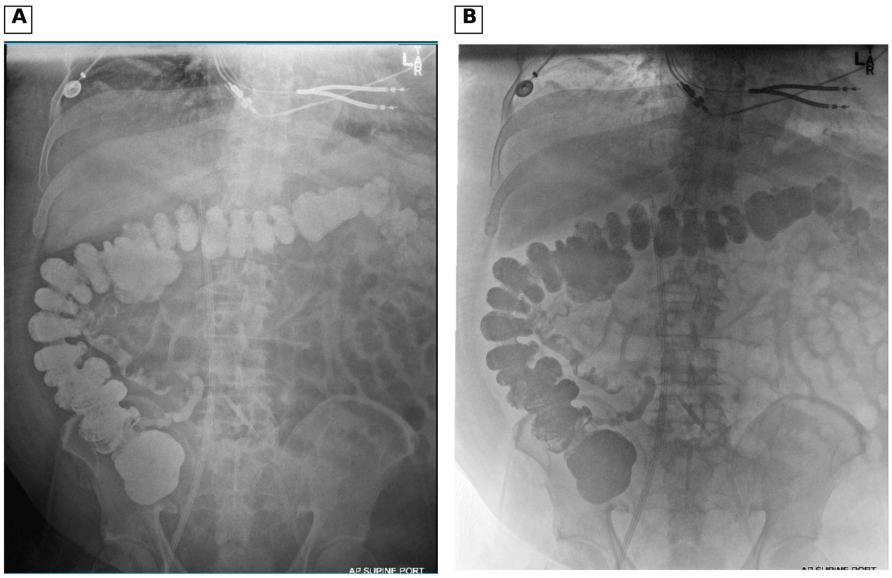


FIGURE 5: Right femoral tunneled dialysis catheter after exchange.

Panel A: Anteroposterior (AP) abdominal radiograph shows the tip of the right femoral dialysis catheter in the intrahepatic inferior vena cava (IVC). The tip of the left femoral catheter is at the left common iliac vein/IVC bifurcation. Panel B: The same findings are shown with grayscale inversion.

The replacement tunneled catheter subsequently functioned adequately during hemodialysis. Approximately 2.5-3.0 L of net ultrafiltration was achieved per session, initially with daily dialysis and subsequently with dialysis every other day.

During the approximately one-day interval between recognition of the malposition and catheter exchange, the catheter was not used for hemodialysis. The patient developed no hematuria, bleeding, catheter-associated thrombosis, hemodynamic deterioration, or clinically significant decrease in hemoglobin. No complication attributable to the catheter malposition or exchange was observed. After a 23-day hospitalization, the patient was discharged to a subacute rehabilitation facility with arrangements for continued outpatient hemodialysis. The principal clinical events and vascular-access procedures are summarized in Table *2*.

Hospital day	Clinical event
Day 1	Presentation after an out-of-hospital cardiac arrest.
Day 2	Admission to the intensive care unit.
Day 3	A temporary left femoral trialysis catheter was placed.
Day 4	The first hemodialysis session was performed through the left femoral trialysis catheter.
Day 6	The existing right femoral triple-lumen central venous catheter was removed.
Day 8	A 44-cm cuffed tunneled dialysis catheter was placed through the right femoral vein.
Day 9	Postprocedural abdominal radiography demonstrated that the catheter crossed the midline, with its tip projecting over the presumed left renal vein. The catheter was not used for hemodialysis.
Day 10	The catheter was exchanged through the existing right femoral tract for a shorter 42-cm tunneled dialysis catheter. Postprocedural radiography confirmed termination within the intrahepatic inferior vena cava.
Day 24	The patient was discharged to a subacute rehabilitation facility with arrangements for continued outpatient hemodialysis.

TABLE 2: Timeline of hospitalization and dialysis access management.

Discussion

This case demonstrates probable cannulation of the native left renal vein by a right femoral tunneled hemodialysis catheter. The catheter followed the expected cephalad course through the right iliac venous system and IVC before making an abrupt transverse turn toward the left at approximately the renal hilar level. This radiographic configuration was most consistent with entry into the left renal vein.

Several features make this case clinically instructive. First, the malpositioned device was a long, cuffed tunneled hemodialysis catheter rather than a conventional infusion catheter. Second, the suspected malposition involved a native renal vein rather than the renal vein of a transplanted kidney with surgically altered pelvic anatomy. Third, both lumens aspirated and flushed normally, and no resistance was encountered during insertion. Technically uncomplicated placement and satisfactory luminal aspiration therefore did not exclude significant intravascular malposition. Finally, routine postprocedure radiography identified the abnormal trajectory before the catheter was used, permitting correction before a catheter-related complication occurred.

Ultrasound guidance improves the safety of femoral venous access by allowing assessment of vessel patency, differentiation of the femoral vein from the adjacent artery, and visualization of the needle during venipuncture. However, ultrasonography limited to the access site does not demonstrate the complete guidewire and catheter course through the iliac venous system, IVC, renal-vein confluence, and more cephalad central circulation [2,3]. Successful ultrasound-guided puncture confirms entry into the intended femoral vein but does not establish the final catheter-tip position.

The direction of a guidewire may be influenced by the orientation of its J-tip, venous anatomy, respiratory movement, vessel caliber, catheter length, and central hemodynamics. This patient had severe cardiomyopathy and radiographic evidence of elevated right-sided pressure, which may have been associated with central venous dilation. However, the mechanism by which the guidewire and catheter entered the presumed left renal vein cannot be determined.

Catheter length may also have contributed to the malposition. Femoral tunneled dialysis catheters must be sufficiently long to traverse the iliac venous system and terminate within a large-caliber segment of the IVC [2,3]. In this patient, the 44-cm catheter reached the renal-vein confluence and turned toward the left, whereas the 42-cm replacement terminated appropriately within the intrahepatic IVC. This 2-cm difference should not be interpreted as a universal threshold. Appropriate catheter length depends on the venipuncture

site, tunnel length, patient body habitus, vascular anatomy, and intended tip location. Confirmation of the guidewire course and final catheter position is more important than nominal catheter length alone.

Malposition of a hemodialysis catheter may cause catheter dysfunction and expose the patient to thrombotic, vascular, or organ-specific complications [3,5-7]. The consequences of delivering high extracorporeal blood flow through a renal vein are not well established. Potential consequences could include renal venous congestion, thrombosis, vessel-wall injury, renal parenchymal injury, and retroperitoneal bleeding. These outcomes remain theoretical in the present case because the catheter was not used and its position was not confirmed by contrast imaging.

Although our patient experienced no adverse event, unrecognized femoral catheter malposition can have serious consequences. Pafitanis et al. described a femoral venous catheter inadvertently positioned within the peritoneal cavity and subsequently used for infusion. Within 48 hours, the patient developed progressive abdominal distension, elevated intra-abdominal pressure, and organ failure requiring emergency laparotomy. Contrast administration through the catheter demonstrated intraperitoneal extravasation, confirming malposition as the cause of abdominal compartment syndrome [11].

A more closely related case was reported by Khor et al. in a renal transplant recipient. A right femoral vascular catheter was inserted under ultrasound guidance without resistance, and aspiration and flushing were normal. Because its position was not confirmed radiographically, continuous venovenous hemodiafiltration was initiated. Computed tomography performed one week later demonstrated that the catheter tip terminated within a superior-pole parenchymal vein of the transplanted kidney, with an associated renal cortical defect consistent with infarction [8].

Piletič et al. subsequently reported a femoral central venous catheter that entered the renal vein of a transplanted kidney. The catheter remained in place for approximately two weeks before the malposition was incidentally identified and corrected [9]. These transplant cases emphasize the additional risks associated with surgically altered pelvic vascular anatomy. In contrast, the present case involved a cuffed tunneled hemodialysis catheter entering the presumed left renal vein in a patient with native renal anatomy. An earlier report by Narlawar et al. also described a central venous catheter positioned in the native left renal vein [10].

Collectively, these reports demonstrate that renal-vein cannulation from a femoral approach is possible, although exceptionally uncommon. The present case adds a distinct scenario involving a 44-cm cuffed tunneled dialysis catheter, radiographic detection before first use, exchange for a shorter catheter, documentation of the corrected position, and an uncomplicated clinical outcome. Because confirmatory venography was not performed, the lack of definitive anatomic confirmation remains an important limitation.

Exchange over a guidewire preserved the existing femoral access site while correcting the catheter position. The replacement catheter subsequently supported hemodialysis with 2.5-3.0 L of net ultrafiltration per session, and post-exchange radiography demonstrated termination in the intrahepatic IVC. The before-and-after radiographs provide a useful comparison between the abnormal transverse course of the original catheter and the expected vertical course of the replacement catheter.

Ultrasound guidance, intraprocedural fluoroscopy, and postprocedural radiography serve complementary but distinct purposes. Ultrasound facilitates safe venous puncture but does not confirm the complete central trajectory of the guidewire or catheter, whereas fluoroscopy permits real-time recognition of an unintended course [1,3]. When a femoral tunneled dialysis catheter is inserted without fluoroscopic visualization of the complete guidewire and catheter trajectory, postprocedural imaging should be reviewed before the first dialysis session. A catheter that deviates from the expected vertical course of the IVC, particularly one that turns laterally near the renal hilar level, should not be used until its position has been clarified [3,8]. If plain radiography is inconclusive, fluoroscopic catheter injection, venography, or cross-sectional imaging may be used to determine its location. Repositioning or exchange should be performed with appropriate imaging guidance when the catheter location remains uncertain or when vascular perforation or extravascular placement is suspected, and the corrected tip position should be confirmed before hemodialysis [1,3].

Conclusions

Malposition of a right femoral tunneled hemodialysis catheter into the left renal vein is an uncommon but potentially consequential complication. Ultrasound guidance confirms venous entry at the puncture site but does not establish the final catheter-tip location. Uncomplicated advancement, normal blood aspiration, and the absence of immediate symptoms do not exclude intravascular malposition.

In this patient, review of routine post-placement radiography before catheter use permitted early recognition of an abnormal trajectory consistent with left renal-vein cannulation. The catheter was withheld from dialysis and successfully exchanged for a shorter catheter terminating in the intrahepatic IVC. No catheter-related complication occurred. Final catheter-tip position should be confirmed before a newly

inserted femoral tunneled dialysis catheter is used, particularly when fluoroscopy is not employed during placement.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Drafting of the manuscript: Noma Shri

Critical review of the manuscript for important intellectual content: Noma Shri, George Horani, Shivanck Upadhyay, Lance Alquran, Mourad Ismail

Supervision: George Horani

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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