DOI: 10.38103/jcmhch.95.5

Case Report

EXHAUSTION OF VASCULAR ACCESS IN A HEMODIALYSIS PATIENT WITH END STAGE RENAL DISEASE: A CASE REPORT

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ABSTRACT

Introduction: *Vascular access is a vulnerable aspect of hemodialysis in patients with end-stage renal disease. In such cases, arteriovenous fistulas are preferred, instead of catheters. Moreover, failure of the current arteriovenous access and catheter dependence often lead to morbidity and mortality.*

Case report: *A 76-year-old female patient presented with reduced vascular access secondary to progressive central venous stenosis. Consequently, an alternative access was created via the popliteal vein. This vein has been used in cases of patients undergoing emergency hemodialysis who did not have vascular access via other conventional routes.*

Conclusion: *Unusual vascular access for emergency hemodialysis is necessary when other routine veins cannot be accessed. The use of arteriovenous fistulas instead of catheterization should be encouraged during the initial hemodialysis stage.*

Keywords: *Case report, vascular access, hemodialysis, central venous stenosis, arteriovenous fistulas.*

I. BACKGROUND

Adequate vascular access is essential for patients undergoing hemodialysis (HD). The Fistula First Initiative and KDOQI guidelines recommend using arteriovenous fistulas (AVF) over placing dialysis catheters [1]. Although central venous catheter (CVC) placement for dialysis is associated with complications [2], it remains a good alternative when native AVF are not accessible. Since the right internal jugular vein is the preferred site for the insertion of HD access catheters, the subclavian vein can also be used to place a dialysis catheter in specific cases. However, subclavian vein insertion sites should be avoided because of the high incidence (25–50%) of central venous stenosis (CVS) [3]. This report presents the case of a patient undergoing HD with exhausted vascular accesses and a temporary vascular access through a less commonly used location.

2. CASE PRESENTATION

A 76-year-old female patient with a history of hypertension, diabetes mellitus, and 7 years of routine HD was admitted to Cho Ray Hospital due to vascular exhaustion for HD (table. 1, history of patient's vascular access since the start of HD).

Table 1: Review of the patient's vascular access history

Date	Event
December 2015	The patient developed the end-stage of the renal disease (ESRD) as a result of diabetes mellitus and became dialysis-dependent. Being unprepared for a long-term vascular access, the patient received hemodialysis initially via left subclavian vein catheter. The catheter was removed after left wrist AVF had matured and became functional.

Received: 21/11/2023. **Revised:** 20/3/2024. **Accepted:** 29/4/2024.

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Date	Event
December 2016	The patient’s left wrist AVF was occluded. A left subclavian vein catheter was used to continue hemodialysis. Finally, a right wrist AVF was established to provide reliable vascular access for hemodialysis until 2022.
March 1st 2022	Right wrist AVF was blocked. A new left elbow AVF was conducted but it was soon occluded. In the meantime, the patient had numerous central vein catheters inserted to both femoral vein and subclavian vein to provide provisional dialysis access during AVF problems. Subsequently dialysis was performed via a right subclavian vein catheter.
March 28th 2022	The patient's subclavian catheter-related infection was treated with systemic antibiotics rather than catheter removal in an attempt to salvage access. A new right basilic AVF was then created.
May 24th, 2022,	Right subclavian HD catheter was removed due to recurrent infection. The patient’s right AVF had not matured and been superficialized.
June 2nd 2022	The patient was referred to Cho Ray Hospital because exhausted vasculature for hemodialysis.

AVF, arteriovenous fistulas; ESRD, end-stage renal disease; HD, hemodialysis.

The patient was alert, agitated, and complained of pain in the bilateral subclavian area and groin. After skipping dialysis for 3 days, there were signs of volume overload, such as edema of the face, hands, and legs, orthopnea, and paroxysmal nocturnal dyspnea. At the initial examination, vital signs were stable with a heart rate of 96 bpm, blood pressure of 140/90 mmHg, temperature of 37^{o}C, respiratory rate of 18 breaths/minute, and oxygen saturation level of 96% (room air while in resting mode). The patient’s weight, height, and body mass index were 49 kg, 155 cm, and 20.39 kg/m^2, respectively. Examination of the patient’s head and neck revealed a central venous catheter (CVC; figure. 1), as well as bruising of the bilateral shoulder area and groin resulting from repeated needle punctures. The patient’s arm was swollen and bruised along the fistula. The heart rhythm was regular, without murmurs. Bilateral inspiratory crackles were heard during lung examination. Other clinical findings were unremarkable.

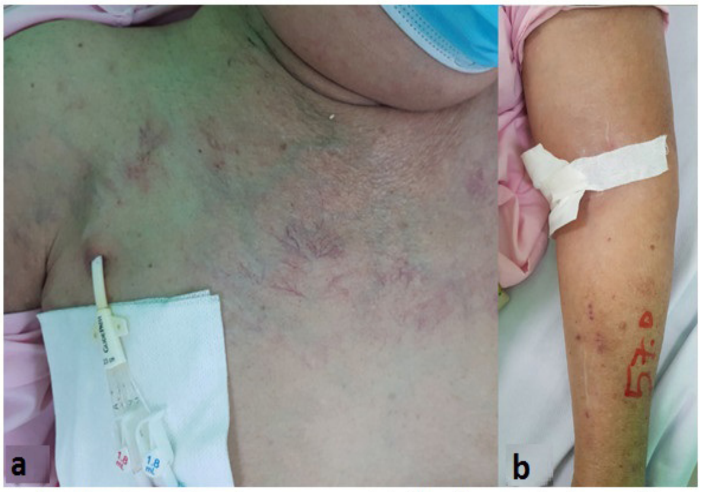

Fig. 1. Clinical signs of central venous stenosis: (a) collateral veins on the chest, and (b) swollen arm.

Figure 1: Clinical signs of central venous stenosis: (a) collateral veins on the chests, and (b) swollen arm

At admission, blood analysis revealed severe anemia with a hemoglobin value of 54 g/L, hematocrit of 17.4%, white blood cell count of 6.7 × 109/L, and platelet count of 182 µL. Biochemical analysis revealed the following values: blood urea nitrogen, 73 mg/dL; serum creatinine, 7.91 mg/dL; estimated glomerular filtration rate (eGFR), 4.49 mL/min/1.73 m^2; sodium, 138 mmol/L; potassium, 6.1 mmol/L; and chloride, 105 mmol/L.

Volume overload and hyperkalemia indicated the need for emergency HD. Dialysis catheter placement and right AVF puncture were unsuccessful. The patient's right elbow AVF was not superficialized, which made cannulation difficult.

Chest computed tomographic angiography (CTA) revealed moderate-to-severe stenosis of the left subclavian and brachiocephalic veins, whereas the right subclavian and brachiocephalic veins remained patent. Pelvic CTA demonstrated nearly occlusive deep venous thrombosis involving the bilateral external iliac and femoral veins, as shown in figure. 2. Heavy calcification of the blood vessels was also observed in all vessels analyzed.

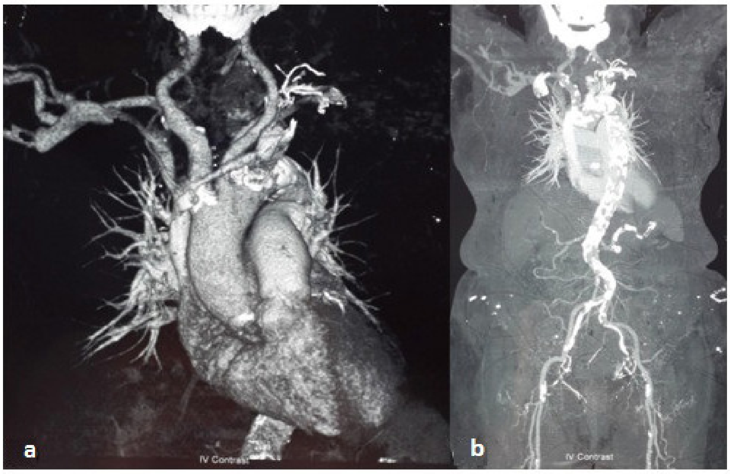

Fig. 2. Computed tomographic angiography images of the (a) chest and (b) body.

Figrue 2: Computed tomographic angiography images of the (a) chest and (b) body

The patient received provisional HD catheters in the bilateral jugular and femoral veins, placed using real-time ultrasound guidance. However, resistance did not allow the passage and placement of the guidewire. As a last resort, the left popliteal vein was punctured using ultrasonographic guidance, and a temporary dialysis catheter was successfully placed, as shown in figure. 3.

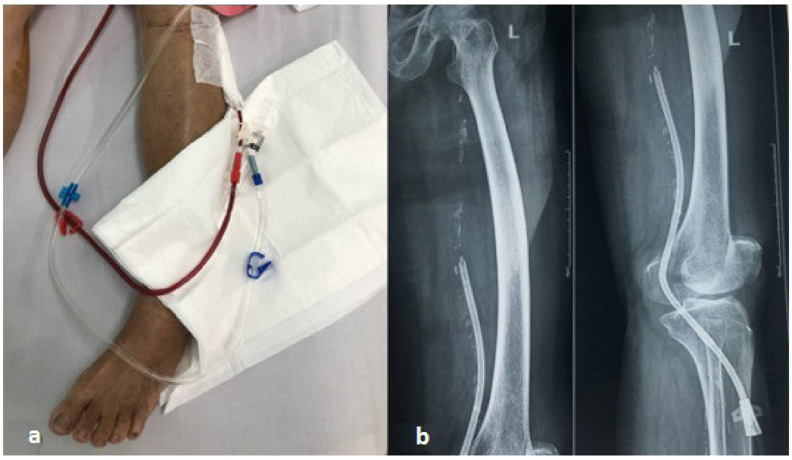

Fig. 3. (a) Left popliteal HD catheter and (b) the respective X-ray images. HD, hemodialysis.

Figure 3: (a) Left popliteal HD catheter and (b) the respective X-ray images. HD, hemodialysis

HD was interrupted due to low blood flow rate [quantitative of blood (Qb), 150 mL/min; arterial pressure (Pa), -120 mmHg; venous pressure (Pv), 150 mmHg] that causes the pump to stop. To solve this issue, an arterial line was connected to the right AVF, and the popliteal vein catheter served as a venous line to return blood. The blood flow rate was stabilized at Qb 200 mL/min, Pa -120 mmHg, and Pv 150 mmHg. Overall, the treatment lasted approximately 3 h with a total ultrafiltration volume of 2500 mL.

Due to the vascular access exhaustion, the patient was advised to switch from HD to peritoneal dialysis; however, her family declined. After the patient returned home, the popliteal vein catheter slipped unintentionally. During the subsequent dialysis treatments, the right AVF was used as the outflow line and the peripheral veins as the inflow line. Nevertheless, establishment of a stable vascular access was challenging because of the depth of the AVFs.

As the right central venous system was still patent in the patient (Figure 2), placement of a short-term (non-tunneled) dialysis catheter into the right subclavian vein was attempted. However, catheter placement was extremely difficult. Two days later, the non-tunneled catheter was replaced with a tunneled catheter through a guidewire. The patient was discharged and, from then on, underwent HD at a district hospital.

At the 3-month follow-up appointment, the patient was stable, her right elbow AVF had become occluded, and her right subclavian tunneled catheter remained functional.

III. DISCUSSION

Considering its importance for disease management and survival, vascular access is a concern in all patients requiring HD. Current guidelines recommend that patients with chronic kidney disease should be examined by nephrologists when their eGFR is < 30 mL/min/1.73 m2 (eGFR categories G4–G5) and subsequent dialysis access should occur when eGFR is 15–20 mL/min/1.73 m2 [2, 4, 5]. There are three types of HD access: native AVF, arteriovenous graft, and CVC. The selection of access type depends on the severity of the disease (acute or chronic initiation of dialysis), vessel anatomy, and current complications. Native AVF is widely regarded as the preferred vascular access as it is associated with fewer vascular access-related events (e.g., infection and thrombotic and nonthrombotic complications). Moreover, creation of a native AVF is recommended 6 months before the start of HD [2, 4].

However, in urgent dialysis situations or when a fistula develops, CVCs for HD (hereafter referred to as HD catheters) are a good alternative. Despite recommendations from the KDOQI and the Fistula First Initiative, 82.6% of new patients requiring HD are set up for dialysis with a CVC instead of a graft or fistula.[6] The preferred insertion sites are the internal jugular and femoral veins [2]. The jugular vein is the preferred choice for central venous catheterization because of its many advantages over other veins [7]. Additionally, the right internal jugular artery is preferable due to its more direct anatomy and the higher prevalence of stenosis on the left side [2, 4]. The subclavian veins are not recommended because of the increasing incidence of insertion-related complications, such as pneumothorax, hemothorax, subclavian artery perforation, and brachial plexus damage, and CVS [8]. Central venous obstruction develops in 40% of individuals with subclavian vein catheters compared to 10% of those who have jugular vein catheters [9]. The use of real-time ultrasound to guide catheter placement can reduce the number of access attempts and other complications [4].

Numerous complications are associated with central venous catheterization, which depend on the vein. For example, there is the immediate risk of arterial puncture and air embolism, as well as the delayed complications of thrombosis and infection for any vein involved. Other risks are more specific to the particular vein, as is the case of pneumothorax, hemothorax, of CVS in the internal jugular or subclavian vein. CVC insertion in the internal jugular and subclavian veins also involves potential injury to adjacent structures (brachial plexus and recurrent laryngeal nerve) [8]. CVS is the worst CVC-related complication because of its association with compromised future vascular access and inadequate dialysis. There are few studies on the true incidence and prevalence of CVS in patients with end-stage renal disease because of the lack of symptomatic patients [10]. Owing to venous congestion, the clinical signs and symptoms of CVS include ipsilateral arm edema, collateral veins on the chest, prolonged bleeding after removing the fistula needle, and elevated venous pressure during routine monitoring. Despite advances in the understanding of its etiology and pathophysiology, CVS remains unresolved. Due to the lack of effective therapies, treatment should focus on the prevention of CVS. A recent study reported an overall morbidity of 13% for de novo hemodynamically significant CVS [11].

For patients with chronic kidney disease, it is recommended that the vasculature should be prepared at least 6 months before initiating HD. The location for AVF should be created preferably at the wrist, and if not possible, at the elbow, preferably in the non-dominant hand. Therefore, autologous veins can be used instead of artificial blood vessels [2, 5]. In our case, the patient was not prepared for dialysis and long-term vascular access was planned, requiring an HD catheter to initiate HD.

Complications resulting from catheter dialysis, not only at the first CVC location, but also on both patient sides, included the subclavian vein, in which catheter placement had been attempted before. Consequently, the patient developed CVS, which was confirmed with clinical signs and diagnostic imaging. The patient also had bilateral chronic femoral veins. A unique feature of this patient was that multiple dialysis catheters were placed, including in the femoral and subclavian veins (left and right sides), contrary to the recommendations for catheter placement [2]. Her AVFs had a short lifespan, and her most recent right elbow AVF was not sufficiently superficial to be cannulated. When admitted to the hospital, the patient required immediate vascular access to address the symptoms and avoid disease progression. As such, the subclavian vein was used to insert the catheter during dialysis, which is generally avoided [9]. The diverse attempts to insert the CVC on numerous days failed. Thus, to cope with failed AVF access and catheter placement, direct arterial puncture was considered as an alternative; typically, in such cases, the radial, brachial, or femoral artery is used for the arterial line and peripheral veins. In addition, we used the catheter as a venous line to return blood. Here, the popliteal vein was selected; moreover, a temporary HD catheter was successfully placed using ultrasound guidance. The choice of this vein to place the dialysis catheter was the last resort because popliteal veins are small and deep, and catheter placement can only be performed under ultrasound guidance. This method is chosen when other options fail or when the patient has to be in a position that is not suitable for placement of venous catheters, as in patients with COVID-19 who must lie in a prone position to increase ventilation. Recent case reports further support the use of the popliteal vein for HD venous access in critically ill patients with COVID-19 in the prone position [12, 13]. In this case, worsening of the patient’s condition was avoided with prompt HD. Despite the preferred use of the radial, brachial, or femoral artery in similar cases using direct arterial puncture, according to the KDOQI guidelines, a temporary HD catheter is intended for situations in which the placement of arterial catheters has a high risk of bleeding or hematoma complications. In such situations, the catheter cannot be used for many days, and there is a risk of ischemia in the distal extremities. In Vietnam, the number of patients using the popliteal veins for emergency HD is not publicly available. To date, two cases have been reported and treated successfully in Cho Ray Hospital, as this center is the last resource for complicated cases from other hospitals.

Short-lived AVFs are caused by CVS. Our patient had complications from CVS, resulting in slowing of blood flow in the AVF, removal of excess water during HD, and leading to highly concentrated blood in the AVF, which may result in thrombosis and occlusion. Due to the exhaustion of HD vascular access, the patient was advised to switch to other renal replacement therapies, including peritoneal dialysis, but the patient’s family refused. Although there is no standard age limit for kidney transplantation [14], older patients have poor transplant prospects owing to other age-related health problems and organ shortage. At the latest follow-up, she was still undergoing HD through the right subclavian tunneled catheter, and her right elbow AVF was occluded. To maintain this modality of renal replacement therapy, there should be careful discussions between nephrologists, interventionists, and vascular surgeons to create new vascular accesses at unusual sites, such as the lower extremities, thorax, or abdomen [15].

IV. CONCLUSION

This case highlights the importance of the "fistula first, catheter last" approach in HD patients. The subclavian approach for HD catheters does not reduce the risk of CVS. Furthermore, the main complication in this case was the exhaustion of vascular accesses. Even so, the main advantage of this treatment course is its creation of a temporary HD access at an unusual site, the popliteal vein, while other vascular accesses recover.

Author's contribution

HVP - Acquisition, analysis, and interpretation of data for the work; Drafting and revision of the manuscript for important intellectual content; intravenous catheter insertion.

TTM - Intravenous catheter insertion.

Conflict of interests

The authors have no conflicts of interest to declare.

Fundings

Funding: This study received no funding.

Statements

This case report aimed to describe the challenges associated with the establishment of vascular access for emergency HD in patients with exhausted veins. This treatment approach is the solution for patients with end-stage renal disease, frequently involving a tunneled cuffed catheter for prolonged periods, when permanent vascular access cannot be established.

Acknowledgment

The author thanks the staff at Cho Ray Hospital for their assistance with data collection and reporting.

Ethical approval

The study was approved by the Ethics Committee for Biomedical Research, University of Medicine and Pharmacy at Ho Chi Minh City (320/HĐĐĐ-ĐHYD, 12th May 2020), and the executive board of Cho Ray Hospital.

The patient provided written consent for the publication of this case report.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

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