Title: Vascular Access Abandonment Despite Use of a Novel Thrombectomy Device, the Penumbra CAT7D

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Introduction:
We present a case of an 86-year-old African American man with a thrombosed native arteriovenous fistula (AVF) in the left upper extremity (LUE). We used the Penumbra CAT7D New Era aspiration technology to perform percutaneous thrombectomy. The “End Stage Kidney Disease Life Plan” is a personalized and comprehensive map for dialysis modalities and access for the patient's lifetime. It must be periodically updated based on patient risk factors (1). If a dialysis vascular access stops working, it can cause severe complications and higher healthcare costs (2). In the United States, less than 50% of vascular accesses remain patent after three years. Despite the prolonged maturation time that delays immediate use, patency rates for AVFs range from 3 to 5 years, compared to 1 to 2 years for AV grafts. Furthermore, over 50% of accesses fail, with AVF failing after a median of 3-7 years and AVG after 1-1.5 years (3,4). Thrombosis is the most common fistula complication and occurs at the stenosis or within the outflow portion of the fistula. The risk of thrombosis increases with the degree of stenosis. Compared to AV grafts, fistulas have lower rates of thrombotic events (5). Primary patency and primary assisted patency were significantly higher for autogenous fistula compared with prosthetic grafts. Secondary patency was higher for autogenous fistulas beyond two months in a large study from the United States renal data system (6). Therefore, ultimate efforts should made to salvage AVF for utilization.

Case description:
Our patient is an 86-year-old African American male with a long-term history of hypertension, diabetes mellitus-type 2, gout, and benign prostatic hypertrophy. He has been in our direct medical care since 2013. He required initiation of hemodialysis in 2015 due to the progression of his kidney dysfunction. Since then, his access has been in use for thrice weekly hemodialysis and AVF salvage being done for almost one decade, requiring several procedures, including a fistulogram followed by medical and or mechanical thrombectomies using different kinds of balloons for angioplasty. He also had multiple endovascular stents placed for outflow stenoses. He presented to us approximately one week after his fistula was thrombosed. A successful declot of his LUE brachiocephalic AV fistula was performed with angioplasty in the inflow and outflow portions of the fistula, as well as mechanical and pharmacologic thrombolysis using Fogarty balloon catheter and tPA, respectively. But his access thrombosed again during HD treatment the day after we performed the above procedure.

We repeated the procedure the following day using a novel CAT7D aspiration device. We found stenosis at the proximal end of the outflow stent complex, the most common site for stenosis in a brachiocephalic AVF. After a standard fistulogram and medical thrombectomy, We aspirated the clot by using a Cat 7d aspiration device back towards the venous-facing sheath; we also had difficulty within the canulation zone due to persistent recoil, which we believe is the culprit lesion causing re-thrombosis. A contrast study showed no residual clot in the outflow segment. We dilated the stenosis within the JA region using a Mustang PTA balloon and endeflator and used a Cat 7d aspiration device several times to the arterial anastomosis and in the outflow towards the outflow stent complex. We tried several times to aspirate a thrombus in the inter-aneurysmal segment of the access within the canulation zone. After numerous attempts at angioplasty of the in-flow of the fistula, we were able to get adequate blood flow for dialysis and felt we were successful in obtaining access patency. Unfortunately, however, the patient was

started on dialysis, and within an hour of the start of treatment, the access was unable to achieve adequate circuit blood flow on dialysis. At this point, further interventions felt futile, and the access was abandoned for a tunneled dialysis catheter.

Discussion:

The interventionist must be aware of foundational principles when performing endovascular thrombectomy; the anatomical location of the thrombus and the clot burden can vary depending on the type of vascular access. In AVG, the thrombus usually extends the entire length of the synthetic graft, whereas, in a clotted AVF, the thrombus is usually located at the juxta-anastomotic segment (5, 7). The timing of endovascular thrombectomy is crucial in AVF thrombosis, as an inflammatory response is triggered with AVF thrombosis. If thrombectomy is delayed for more than 2-3 days, it may cause a clot to adhere to the vessel wall and pose challenges compared with AVG thrombosis, which can be done up to 2 weeks after an episode of thrombosis (6, 8). As in our case, we maintain the same approach to attempt to declot sooner after his admission rather than later, but he presented to us almost one week after his access was thrombosed. Other than medical thrombolysis with Tissue plasminogen activator(tPA), Urokinase, or streptokinase, several mechanical devices are used in this era, including a vacuum-assisted thrombectomy catheter and Penumbra CAT7D. There are several modern approaches for vascular thrombectomies that are beyond the scope of this abstract. Mechanical devices like vacuum-assisted thrombectomy catheters and Penumbra CAT7D are used with varying success rates. The results are conflicting; some studies showed the benefit of using these vacuum devices for AVF and AVG, with a 91.4% clinical success rate with one major complication of perforation, one thrombosis, and hematoma in one patient (7, 9) in some studies while other showed inferiority of one on other types like study comparing different modalities of mechanical thrombus aspiration found that Penumbra catheter performed statistically significantly lower than other devices like Angiojet and Trerotola (8,10).

Vascular access continues to be a challenging area of practice that requires a commitment of resources, time, and energy to complete the necessary studies to inform some of the issues better. Recent vascular access guidelines also mention it (1). Vascular access is a “lifeline” for End-stage renal disease (ESRD) patients on hemodialysis(HD). As we know, Autogenous fistulas are associated with a longer time to catheter-free dialysis but better patency, lower infection risk, and lower mortality compared with prosthetic grafts in the general population (10).

Innovations in vascular access salvage are needed, supported by extensive clinical trials and discriminations between different available devices, for improved clinical outcomes and justified utilization based on a better understanding of these vascular gadgets.

Reference:

1. Lok CE, Huber TS, Lee T, et al. National Kidney Foundation. KDOQI clinical practice guideline for vascular access: 2019 update. Am J Kidney Dis 2020;75(4, Suppl 2):S1–S164
2. Al Shakarchi J, Inston N, Jones RG, Maclaine G, Hollinworth D. Cost analysis of the hemodialysis reliable outflow (HeRO) Graft compared to the tunneled dialysis catheter. J Vasc Surg 2016;63(04): 1026–1033
3. Al-Jaishi AA, Oliver MJ, Thomas SM, et al. Patency rates of the arteriovenous fistula for hemodialysis: a systematic review and meta-analysis. Am J Kidney Dis 2014;63(03):464–478
4. Beathard GA. Management of complications of endovascular dialysis access procedures. Semin Dial 2003;16(04):309–313
5. Al-Jaishi AA, Liu AR, Lok CE, Zhang JC, Moist LM. Complications of the Arteriovenous Fistula: A Systematic Review. J Am Soc Nephrol. 2017 Jun;28(6):1839-1850.
6. Arhuidese IJ, Orandi BJ, Nejim B, Malas M. Utilization, patency, and complications associated with vascular access for hemodialysis in the United States. J Vasc Surg. 2018 Oct;68(4):1166-1174.
7. Kitrou PM, Katsanos K, Papadimatos P, Spiliopoulos S, Karnaba- tidis D. A survival guide for endovascular declotting in dialysis access: procedures, devices, and a statistical analysis of 3,000 cases. Expert Rev Med Devices 2018;15(04):283-291
8. Lawson JH, Niklason LE, Roy-Chaudhury P. Challenges and novel therapies for vascular access in haemodialysis. Nat Rev Nephrol 2020;16(10):586–602
9. Clement M, Stephen D, Yann B, Francois P, Nicolas Grenier, Jos B, Bella H. Mechanical Thrombectomy in Acute Thrombosis of Dialysis Arteriovenous Fistula and Grafts using a Vacuume-Assisted Thrombectomy Catheter: A multicenter study.JVIR.2018;29(7):993-997.
10. Adam H, Anthony G, Jessica S, Jordan B, Charles B, Amit D, and Abindra S. Comparing Patency Rates of Arteriovenous Dialysis Access following Percutaneous Thrombectomy Using Various Catheter Directed Therapies. Ann Vasc Surg 2023; 92: 131–141