Salvage of autogenous dialysis access with balloon-assisted thrombin injection

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ABSTRACT

Arteriovenous fistulas are known to be one of the most enduring and safe hemodialysis access modalities. However, access preservation can be challenging in the setting of degeneration, including the development of complex pseudoaneurysms. Prolonged compression or thrombin injection can risk thrombosis of the fistula, and covered stent use can predispose the access to infection and other stent complications. We present a case in which endovascular balloon occlusion was used to facilitate the use of ultrasound-guided thrombin injection to resolve a dialysis access pseudoaneurysm by transiently reducing flow and preventing thromboembolism. This method is a safe, effective, and minimally invasive technique that should be considered for salvage of autogenous access compromised by pseudoaneurysm development. (J Vasc Surg Cases and Innovative Techniques 2020;6:686-9.)

Keywords: Balloon occlusion; Fistula; Interventional; Renal dialysis; Thrombin; Ultrasonography

Pseudoaneurysm (PSA) formation is a common complication affecting arteriovenous hemodialysis access, often resulting from repeated cannulation and trauma at the access site. Larger PSAs are at risk of complications such as rupture, distal embolization, and infection and, thus, require careful management. Although PSAs can be addressed with open surgical repair, these procedures are associated with a significant risk of complications. Endovascular stent placement is a minimally invasive approach that has been noted for its safety and efficiency in PSA exclusion and access preservation. However, this approach can result in other complications, including bleeding secondary to the requisite use of antiplatelet agents, persistent infections, and stent migration or fracture.[1-3]

An alternative to endovascular stent graft placement for PSA management is ultrasound-guided thrombin injection (UGTI). Although successful use of UGTI to treat PSAs has largely been discussed in the context of femoral PSAs,[4-6] several reports have also demonstrated its utility in autogenous dialysis access PSAs.[7-9] Like stent placement, UGTI is a minimally invasive approach to fistula PSA management; however, it offers the additional advantage of preserving the autogenous fistula without requiring the placement of prosthetic material. Safe usage of UGTI has typically been limited by the need for relatively narrow, long-necked PSAs; however, many arteriovenous fistula (AVF)-associated PSAs will tend to have a wider neck generated from multiple accesses at a single locus of repurposed venous tissue.[10-12] Our group previously described our success with an endovascular balloon-based flow-reduction aided UGTI technique in the management of complex cases and for lesions with short or wide necks.[10,13] In the present report, we have described the application of this approach to the management of a PSA affecting the basilic vein of a brachiobasilic dialysis fistula. The use of this technique allowed us to achieve rapid thrombosis of the PSA and also to preserve the integrity of the autogenous fistula, thus avoiding the introduction of prosthetic material into the access channel. Given the minimally invasive nature of our therapy, the entire intervention was managed on an outpatient basis within 2 days from the onset of the patient's symptoms. The patient provided written informed consent, and his medical records were retrospectively reviewed with the approval of our institutional review board.

CASE REPORT

An 84-year-old man with end-stage renal disease and a left brachial–basilic fistula was referred to our office-based laboratory after a recent hemodialysis session during which he developed significant pain and swelling shortly after access. He denied any previous issues with accessing this fistula, which had recently finished maturation. On examination, significant focal tenderness and swelling was present in the middle third of the fistula, with a palpable thrill proximally and distally.

In the setting of a documented contrast allergy, the entire procedure was performed with a combination of carbon dioxide-contrast angiography, external beam ultrasonography, and intravascular ultrasound (IVUS) scanning. Conventional ultrasonography confirmed the presence of a large PSA arising deep

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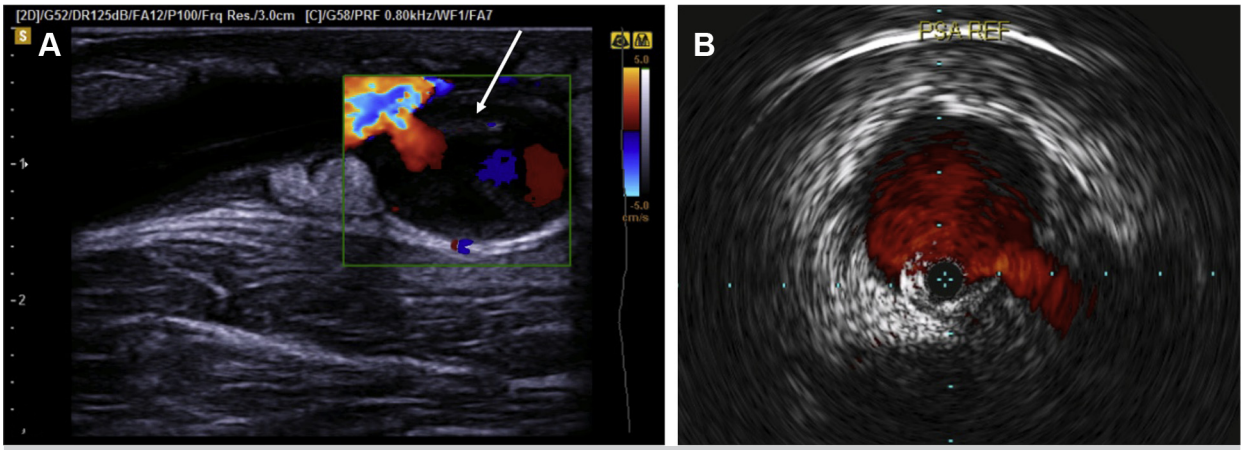

Fig 1. Preoperative and intraoperative images demonstrating pseudoaneurysm (PSA; *arrow*) within brachiobasilic dialysis fistula, as seen on external beam ultrasound scan **(A)** and intravascular ultrasound scan **(B)**.

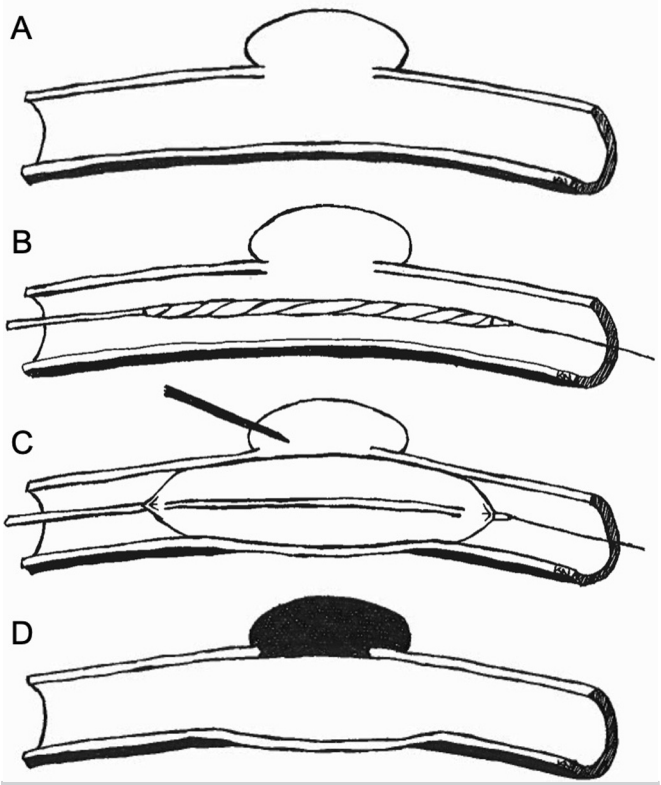

Fig 2. Illustrations of technique demonstrating ultrasound-guided thrombin injection with balloon occlusion. **A,** Preoperative fistula with pseudoaneurysm (PSA). **B,** The fistula was accessed and the balloon positioned across PSA neck. **C,** The balloon was inflated and PSA accessed percutaneously for thrombin injection. **D,** Final result demonstrating preserved autogenous fistula with thrombosed PSA.

to the fistula with a wide mouth, no appreciable neck, and some local mass effect on the AVF (Fig 1, *A*). The fistula was accessed using a microaccess system, which we then exchanged for a short 6F sheath. Carbon dioxide angiography confirmed the decreased luminal caliber of the middle third of the fistula adjacent to the PSA and one slightly distal area of moderate stenosis with no evidence of central venous stenosis.

We decided to perform percutaneous thrombin injection to thrombose the PSA. An IVUS probe was advanced to assess the size and relationship of the fistula and PSA (Fig 1, *B*). Given the unusual configuration of the PSA, which also had a short neck and wide mouth, we elected to use an intravascular balloon to transiently reduce flow through the fistula and occlude the PSA neck. Our previous experience had demonstrated that this approach can prevent extension of the thrombosis into the main lumen and reduce the risk of embolism as the thrombin is injected (Fig 2). The fistula had a diameter of 6 mm on IVUS scanning; thus, a 7-mm × 40-mm balloon (10% oversized) was selected to exclude the PSA during thrombin injection.

With the balloon in place but not yet inflated, the injection site was anesthetized and the dome of the PSA was punctured with a microaccess needle under ultrasound guidance (Fig 2, *B* and *C*). The balloon was inflated to the nominal pressure (Fig 2, *C*). Saline was then injected into the PSA under color flow guidance, which demonstrated swirling and confirmed access to the PSA. The needle was maintained in place as the syringe was replaced with one containing thrombin. We then slowly injected the thrombin solution while observing the PSA with B mode ultrasonography and watched the echogenic thrombus as it formed within the PSA (Fig 3). We scanned the entire PSA to confirm thrombosis before removing the needle and slowly taking the balloon down. The balloon was deflated after an additional 30 seconds (2 minutes total occlusion time), and external beam ultrasonography revealed the absence of residual flow in the PSA. As the balloon was being deflated, we switched to color flow Doppler ultrasonography to assess for any residual flow in and out of the PSA.

The additional stenotic region of the fistula, located separately from the PSA, was then treated with balloon angioplasty under carbon dioxide angiography. IVUS and carbon dioxide fistulography confirmed complete resolution of the PSA and apparent resolution of the dynamic compression effect of the AVF with minimal residual stenosis (Fig 4). Immediately after the

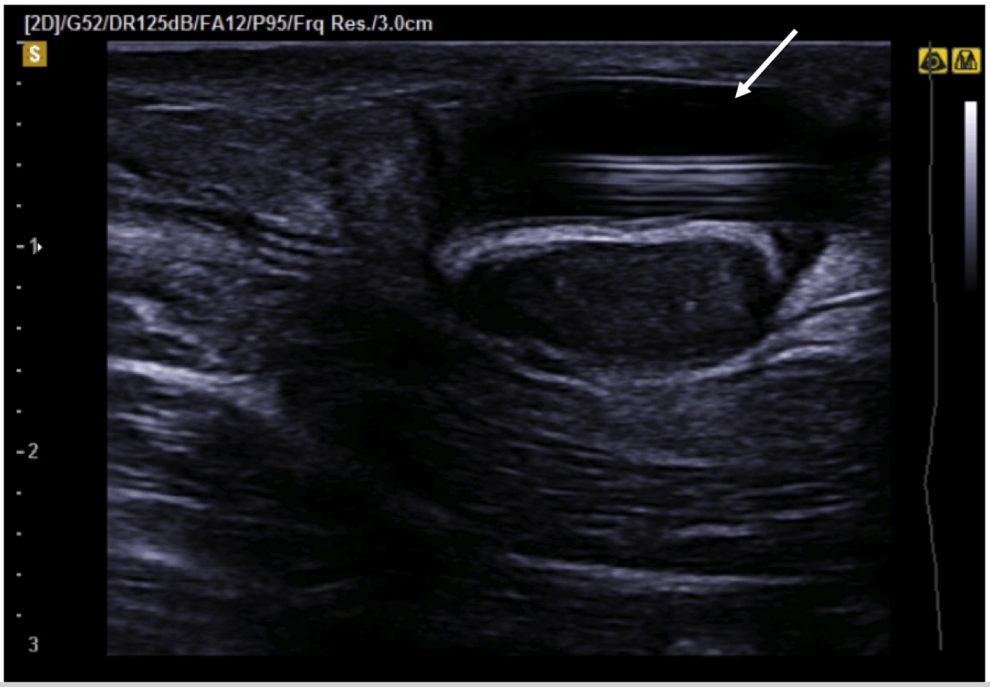

Fig 3. Intraoperative external beam ultrasound image demonstrating inflated balloon (*arrow*).

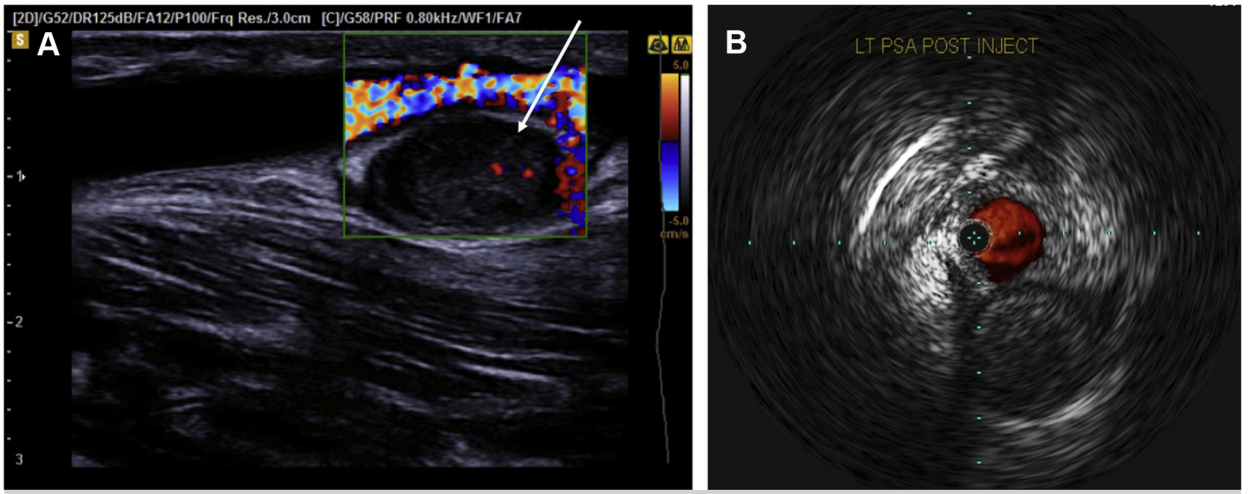

Fig 4. Images after injection demonstrating thrombosed pseudoaneurysm (PSA; *arrow*) seen via external beam ultrasound scan **(A)** and intravascular ultrasound scan **(B)** with preserved arteriovenous fistula (AVF) lumen.

procedure and at the 1-week follow-up examination, the patient reported resolution of the pain and swelling at the site. At the 9-month follow-up visit, the AVF had been used successfully for hemodialysis, and the patient had not required catheter placement or any procedure to support patency. His nephrologist reported no issues with post-access bleeding, high venous pressures, or recurrent symptoms at the injection site.

DISCUSSION

Preservation of access is a critical goal in the management of dialysis fistulas complicated by PSAs. Although endovascular stenting is a minimally invasive treatment approach that can be used for PSA exclusion, stent-graft placement into AVFs introduces the risk of infection and other stent complications, such as migration, fracture, rupture, and erosion.[2,3] Additionally, because PSAs often develop at cannulation sites, stent-graft coverage of these sites can necessitate subsequent through-stent cannulation, increasing the risk of stent-graft damage and complications.[14-16] Thus, it is reasonable to preserve the autogenous fistula and avoid stent placement whenever possible.

We have presented a case in which an alternative method, UGTI with endovascular balloon occlusion, was successfully used to treat the PSA and maintain the integrity of the autogenous dialysis fistula. Isolated cases of the use of UGTI for dialysis fistula-associated PSAs have been reported; however, to the best of our knowledge, none of these cases had involved a PSA of the fistula itself but rather an arterial or venous segment immediately proximal or distal to the fistula.[7-9] Although balloon-assisted thrombin injection is not presently a widely accepted technique, we and other investigators have described its safe use in the setting of femoral PSAs.[10,13] We have successfully adopted the use of balloon-assisted local flow reduction to facilitate thrombin injection and have found this approach to be especially useful to reduce the risk of distal embolization in the setting of wide or short necks. The present report is intended to highlight the use of this adjunct in the specific case of dialysis fistula PSAs, in which the neck could be wider owing to serial repeat punctures in the repurposed venous tissue.

This approach to the management of dialysis AVF PSA offers several major advantages. First, by inducing definitive thrombosis of the PSA sac under direct visualization, UGTI allows for preservation of an autogenous fistula without the use of a prosthetic stent-graft. Because thrombosis is a significant concern in AVF stenting, our technique could contribute to the overall longevity of the fistula.[17] Second, the use of balloon occlusion with UGTI serves to contain the thrombin during the injection despite a wide or short aneurysm neck, thus preventing embolization. Third, this technique is favorable in that it does not prevent future interventions, if needed. Because the native AVF anatomy and functionality is preserved, we believe this intervention could have a role in primary maintenance of autologous fistulas.

However, although the description of the present case offers significant insight into the management of dialysis fistula PSAs, it is not without limitations. First, this is a limited example of one successful application of this procedure. Additionally, the immediate success of the procedure and relatively short follow-up period cannot inform the long-term outcomes or complications that might arise. Thus, the findings from the present case require validation in a larger cohort and with a longer follow-up period to assess for fistula durability and outcomes over time.

CONCLUSIONS

Arteriovenous dialysis fistulas compromised by PSA formation require conscientious management to preserve access and salvage the autogenous fistula. UGTI with balloon occlusion is a safe, effective, and minimally invasive technique that should be considered for rescuing dialysis fistulas compromised by PSAs.

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