Successful Endovascular Treatment of a Hemodialysis Graft Pseudoaneurysm by Covered Stent and Direct Percutaneous Thrombin Injection

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ABSTRACT

Vascular access for hemodialysis remains a challenge for nephrologists, vascular surgeons, and interventional radiologists alike. Arteriovenous fistula and synthetic grafts remain the access of choice for long-term hemodialysis; however, they are subject to complications from infection and repeated needle cannulation. Pseudoaneurysms are an increasingly recognized adverse event. At present, there are many minimally invasive methods to repair these wall defects. We present a graft pseudoaneurysm, which required a combination of endovascular stent graft placement and percutaneous thrombin injection for successful occlusion.

More than 300,000 patients with end-stage renal failure (ESRF) undergo hemodialysis in the United States at present (1). Each of these patients needs some form of vascular access to allow sufficient blood flow for hemodialysis, which is administered up to three times weekly. Currently, the three forms of long-term access most commonly used are the native (Brescia-Cimino) fistula, the synthetic polytetrafluoroethylene (PTFE) graft, and the tunneled cuffed catheter. The surgically created arteriovenous fistula (AVF) is the vascular access route of choice for hemodialysis in accordance with the National Kidney Foundation (NKF) Guidelines (2,3). While AVF and grafts are the gold standard for hemodialysis, they are prone to complications, which can cause malfunction and adversely affect viability of this vascular access route. As limited sites are available for vascular access, preservation of existing access routes are paramount for patient survival.

Large pseudoaneurysms arising from the PTFE graft or AVF are an important complication, which the NKF recommends repair of, if the size of the aneurysm limits available dialysis cannulation sites or the integrity of the overlying skin is compromised (4). There are a number of surgical, endovascular, percutaneous, and ultrasound (US) guided options available for pseudoaneurysm repair.

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Seminars in Dialysis—Vol 21, No 6 (November–December) 2008 pp. 553–556
DOI: 10.1111/j.1525-139X.2008.00476.x

We report the successful occlusion of a wide-necked graft pseudoaneurysm using a combination of endovascular stent graft deployment and direct percutaneous thrombin injection.

Case Report

A 34-year-old hemodialysis dependent, male patient noticed gradual enlargement of a swelling just above his right antecubital fossa, over a 4-week period. While attending for hemodialysis via a right PTFE graft, the swelling became mildly painful and was noticed by the nursing staff. On examination by the nephrologist, a large 5-cm pulsatile mass overlying the graft, above the right antecubital fossa was palpated. An audible bruit was heard on auscultation. Flow was palpated within the graft via the presence of a thrill and distal arterial flow to the hand was preserved. Due to the enlarging size of the pulsatile mass and the pain, a referral was made to the Vascular Surgical Team, who suspected a pseudoaneurysm.

Initial Imaging

A color Doppler US was performed which confirmed the clinical suspicion of a large pseudoaneurysm arising from the PTFE graft (Fig. 1A). The pseudoaneurysm measured 6×4 cm in diameter, with a wide neck of 2.1 cm and demonstrated characteristic Yin Yang blood flow within it. Blood flow was preserved within the graft fistula (Fig. 1A). US-guided compression of the wide aneurysmal neck was then performed. However, following 30 minutes of compression, there was no change in

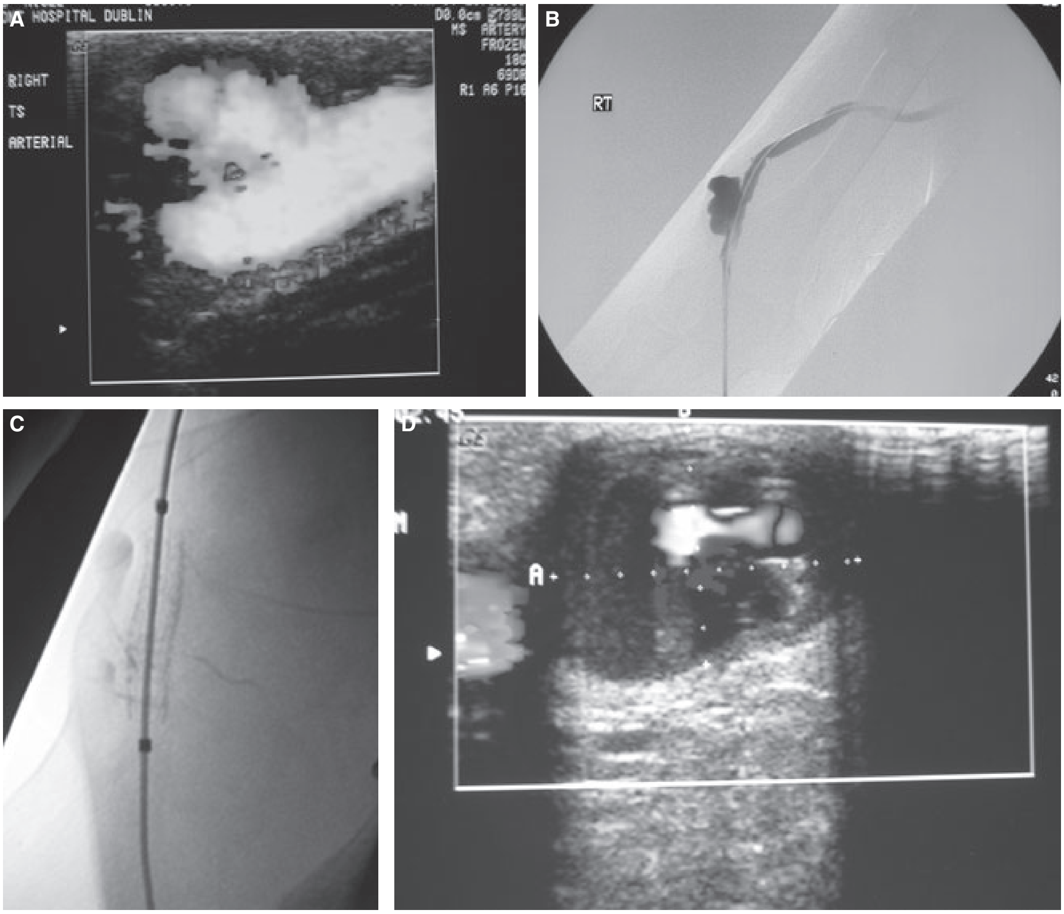

FIG. 1. (A) Doppler ultrasound demonstrating active blood flow within the aneurysmal sac, a wide aneurysmal neck, along with normal flow within the graft. (B) Digital subtraction fistulogram confirms the ultrasound findings of a large pseudoaneurysm, with a wide neck arising directly form the graft fistula just above the antecubital fossa. (C) Endovascular deployment of covered stent across the neck of the pseudoaneurysm with some residual contrast material within the aneurysm sac. (D) Doppler ultrasound of the pseudoaneurysm following covered stent deployment demonstrates some thrombus formation. However, there remains some flow within the centre of the aneurysmal sac. Therefore, percutaneous ultrasound guided thrombin was introduced to completely occlude the sac.

the aneurysmal sac, with continued Yin Yang blood flow. The neck was too wide for percutaneous US-guided thrombin injection; therefore, a fistulogram was needed for further percutaneous treatment planning.

Endovascular Procedure

Following informed consent, under sterile technique, a formal digital subtraction fistulogram, from the antecubital fossa, was performed in a dedicated Interventional Radiology suite. Fistulography confirmed the US findings of a large wide-necked pseudoaneurysm, arising directly form the graft just above the antecubital fossa, with no evidence of any graft stenosis (Fig. 1B). The treatment options at this point were endovascular or surgical, as the US compression had failed and the neck was too wide for US-guided thrombin injection. Endovascular options consisted of a covered stent, detachable balloons, coil embolization, or balloon inflation while percutaneous thrombin was injected. Due to success in the literature with covered stents (5,6), it was elected to use a covered stent (Viabahn Endoprosthesis, 6 mm × 2.5 cm; WL Gore, Flagstaff, AZ, USA) to occlude the pseudoaneurysm.

Initially, a purse string suture was fashioned around the access site following administration of local anesthesia (1% Lignocaine s/c) with the suture remaining untied until the end of the procedure. The graft was then cannulated directly high in the medial aspect of the right upper limb just below the axilla, under US guidance, using a micropuncture kit (Cook, DK-4632 Bjaeverskov, Denmark). A regular J guidewire (0.035 in; Cook, DK-4632) was inserted via the 5Fr sheath of the micropuncture kit, and placed into the graft beyond the neck of the pseudoaneurysm. A 9Fr sheath (Avanti, Cordis, Roden, The Netherlands) was placed into the PTFE graft over the J guidewire. The position of the pseudoaneurysm neck was confirmed by contrast injection (Visipaque, 320 mg I/ml, Iodixanol; Amersham Health, AS N-0401, Oslo, Norway) to enable accurate stent graft deployment. 3000 IU heparin was given via the sheath. The covered stent (Viabahn Endoprosthesis, 6 mm × 2.5 cm; WL Gore) was deployed across the neck of the pseudoaneurysm (Fig. 1C). The dimensions of the stent were determined by a prior US of the graft and pseudoaneurysm. Another fistulogram following stent deployment demonstrated a small persistent leak of contrast material into the aneurysmal sac, despite balloon expansion of the stent. It was felt that this small leak may thrombose spontaneously, therefore the sheath was removed, purse string suture secured and a Doppler US scheduled for the following day.

There was no spontaneous thrombosis of the small residual leak around the covered stent on Doppler US; however, the aneurysmal sac did demonstrate some thrombosis within it, with some residual blood flow (Fig. 1D). Due to the residual blood flow it was elected to place, under US guidance, thrombin directly into the aneurysmal sac via the percutaneous route. Thrombosis was seen immediately, with no flow within the sac.

Follow-up Doppler US at 1 week confirmed no residual flow within the sac. Clinical follow-up in ongoing, as the patient attends our institution for dialysis sessions three times per week. Over a 6-month period, there has been regression of the swelling, with no further symptoms and good flow rates on hemodialysis. We have recommended that the covered stent should not be punctured directly during dialysis as there is a long length of PTFE graft remaining above and below the site of the stent to facilitate vascular access. The site of the stent graft has been tattooed for ease during dialysis sessions.

Discussion

Ideally patients requiring renal replacement therapy aspire to renal transplantation; however, at some point in their treatment most patients with ESRF will require hemodialysis, with up to 60% treated with hemodialysis at any one time. The gold standard hemodialysis vascular access is a cephalic vein to radial artery fistula, with synthetic PTFE graft as second option. These access routes have a finite lifespan, with their natural history comprising a series of multiple revision procedures to salvage and maintain access (7). Each time a particular vascular access site is exhausted, this increases the risk of terminal access difficulties and eventually contributes to patient death (5). Many authors have stressed the importance of staying committed to preserving functioning dialysis access routes by any feasible method, either endovascular or surgical (5,6,8,9).

Arteriovenous fistula or PTFE graft wall disruption, as a consequence of trauma (penetrating or blunt), inflammation/infection, or iatrogenic causes, may result in pseudoaneurysm formation. Clinically, pseudoaneurysms maybe silent, present with local signs due to mass effect of the sac itself or present with systemic features including distal ischemia, embolization, or sepsis. The most feared presentation is rupture, which can have catastrophic consequences (10). Most likely etiology of dialysis graft pseudoaneurysms is the repetitive needle puncture necessary for adequate creatinine clearance during long-term hemodialysis. Failure to rotate the needle access sites, results in wall thinning, leading to graft weakness with subsequent bulge due to high venous pressure and eventual pseudoaneurysm formation. Incidence rates range from 2% to 10% in a number of published series (11–13). Open surgical repair, previously the mainstay of treatment, is now complemented, where feasible, by image-guided occlusion methods. These minimally invasive techniques are employed to achieve occlusion of the aneurysmal sac and include US-guided compression of the pseudoaneurysmal neck (14), direct US-guided percutaneous thrombin injection (15–17), deployment of detachable balloons (18), and placement of covered stents (5–7,19,20). Pseudoaneurysms at various other anatomical sites have been managed using transcatheter embolization with a variety of agents, namely coils (21), glue (22), Gelfoam, and sclerosing agents.

Ultrasound-guided compression of pseudoaneurysms is regarded as the initial first-line treatment option of femoral arterial pseudoaneurysms (14,23), likely due to availability, ease, cost effectiveness, and minimally invasive nature. However, there are varying degrees of success, with rates quoted as between 64% and 90% (23,24). The main factor contributing to failure is size > 4 cm (24), which may account for the failure of US to occlude the large aneurysm in this case. It is important not to occlude blood flow within the AVF or graft during the aneurysmal neck compression and thus it has been suggested that US-guided manual compression should be performed, so that the thrill of the AVF or graft can be felt concurrently (14).

Wide-necked pseudoaneurysms in any arterial site are not suitable for percutaneous thrombin injection alone, due to the risk of distal embolization of the thrombin and resultant thrombosis of the distal artery. Therefore, this patient was not deemed to be suitable for percutaneous thrombin due to the 2.1 cm wide aneurysmal neck. Due to the success of many published series (5–7,19,20), a covered stent was chosen as the method of occlusion for this particular graft pseudoaneurysm. We elected to use the PTFE Viabahn Endoprosthesis (WL Gore) covered stent due to its flexibility and the range of sizes available. Vesely (6) reported an initial 100% successful occlusion of PTFE graft pseudoaneurysms following Gore Viabahn Endoprosthesis deployment; however, four patients out of the 11 in the series had some recurrence of their pseudoaneurysms on follow-up. Other available stent grafts include the Wallgraft (Boston Scientific/Medi-tech, Natick, MA, USA) and the Fluency (Bard, Tempe, AZ, USA), the latter requiring a smaller 8Fr introducer sheath than the 9Fr required for the Viabahn. We recorded a small immediate leak into the sac, which did not resolve at 24 hours, necessitating a complementary technique of percutaneous thrombin injection. Time may have resulted in eventual thrombosis of the aneurysmal sac, however, due to the patient's young age and active lifestyle, complete sac occlusion was the desired outcome in this case. As the neck was now occluded with the stent graft, it was safe to inject thrombin under US guidance. To date, at 6-month follow-up, this aneurysm has not recurred and in fact has reduced in size.

In accordance with Ryan et al. (5), we used a purse string suture prior to puncturing the PTFE graft to facilitate adequate hemostasis at the conclusion of the procedure. Also in contrast to Hausegger et al. (25), we did not recommend cannulation of the stent for dialysis, as these authors reported recurrence of the pseudoaneurysms following stent deployment when the stent was cannulated.

In conclusion, a combination of interventional procedures may be necessary for the successful treatment of challenging vascular pathologies as we demonstrate in this case, which required both a covered stent graft and percutaneous thrombin administration, to successfully occlude a dialysis graft pseudoaneurysm.

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