

Patency of Wallstents Placed at the Venous Anastomosis of Dialysis Grafts for Salvage of Angioplasty-Induced Rupture

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Abstract

Purpose: To retrospectively evaluate the patency of Wallstents placed at the venous anastomosis of polytetrafluoroethylene (PTFE) hemodialysis grafts to preserve function following angioplasty-induced rupture.

Methods: The charts of all patients who underwent percutaneous angioplasty of functioning hemodialysis PTFE grafts between September 1997 and September 2001 were retrospectively reviewed. A total of 414 angioplasties were performed. Nine cases of rupture at the venous anastomosis managed with stent placement were identified (7 women, 2 men). Two grafts were loop grafts, seven grafts were straight grafts. All stents placed were Wallstents; six stents were 8 × 40 mm, the remaining three were 8 × 20 mm, 8 × 60 mm and 10 × 42 mm. Average follow-up was 13 months.

Results: Technical and clinical success of stent placement was 100%. The primary patency rates (±SE) of stents placed at the venous anastomosis were 88% (12%) at 30 days, 63% (17%) at 90 days, 33% (18%) at 180 days and 17% (15%) at 360 days. The secondary patency rates (±SE) were 89% (11%) at 90 days, 76% (15%) at 180 days and 69% (23%) (6 stents patent) at 360 days. During follow-up, one graft was removed because of infection, one patient died and another was lost to follow-up. A single minor complication of a puncture site hematoma occurred (11%) with no major complications.

Conclusions: This small retrospective series suggests that Wallstent placement following angioplasty-induced venous anastomotic rupture is effective for preserving dialyzable flow in hemodialysis grafts. Patency is comparable to that of stents placed for reasons other than rupture.

Key words: Hemodialysis—Angioplasty—Stents—Polytetrafluoroethylene—Rupture

Percutaneous transluminal angioplasty is an accepted method for treatment of recurring stenosis at the venous anastomosis of hemodialysis grafts to maintain graft function [1–3]. However, local factors during balloon angioplasty can result in uncontrolled rupture of the venous anastomosis. Various methods for managing this event have been described including simple observation, prolonged inflation of the balloon catheter to tamponade the area of bleeding and stent placement. When these measures fail, deliberate thrombosis of the graft may be required [4–7]. Continued bleeding in this area can lead to loss of the graft as well as localized complications such as nerve palsy and pseudoaneurysm formation [1–3]. In addition, surgical salvage following perigraft hemorrhage is often difficult or impossible. Stent placement at the venous anastomosis for rupture following angioplasty in arterial venous grafts has been described as an effective method to salvage graft function percutaneously. The literature regarding patency of stents placed to preserve function following rupture is somewhat limited [4–7]. In this small series, we retrospectively evaluated our primary and secondary patencies for this method of hemodialysis graft salvage following rupture.

Materials and Methods

From September 1997 to September 2001, a total of 414 angioplasties were performed at the venous anastomosis. Only patients with mature (in use for a minimum of 2 months prior to intervention) PTFE grafts, which were not thrombosed at the time of intervention, were included in this study. Of these angioplasties, nine patients were treated (7 women, 2 men) for angioplasty-induced rupture at the venous anastomosis with Wallstents to preserve graft

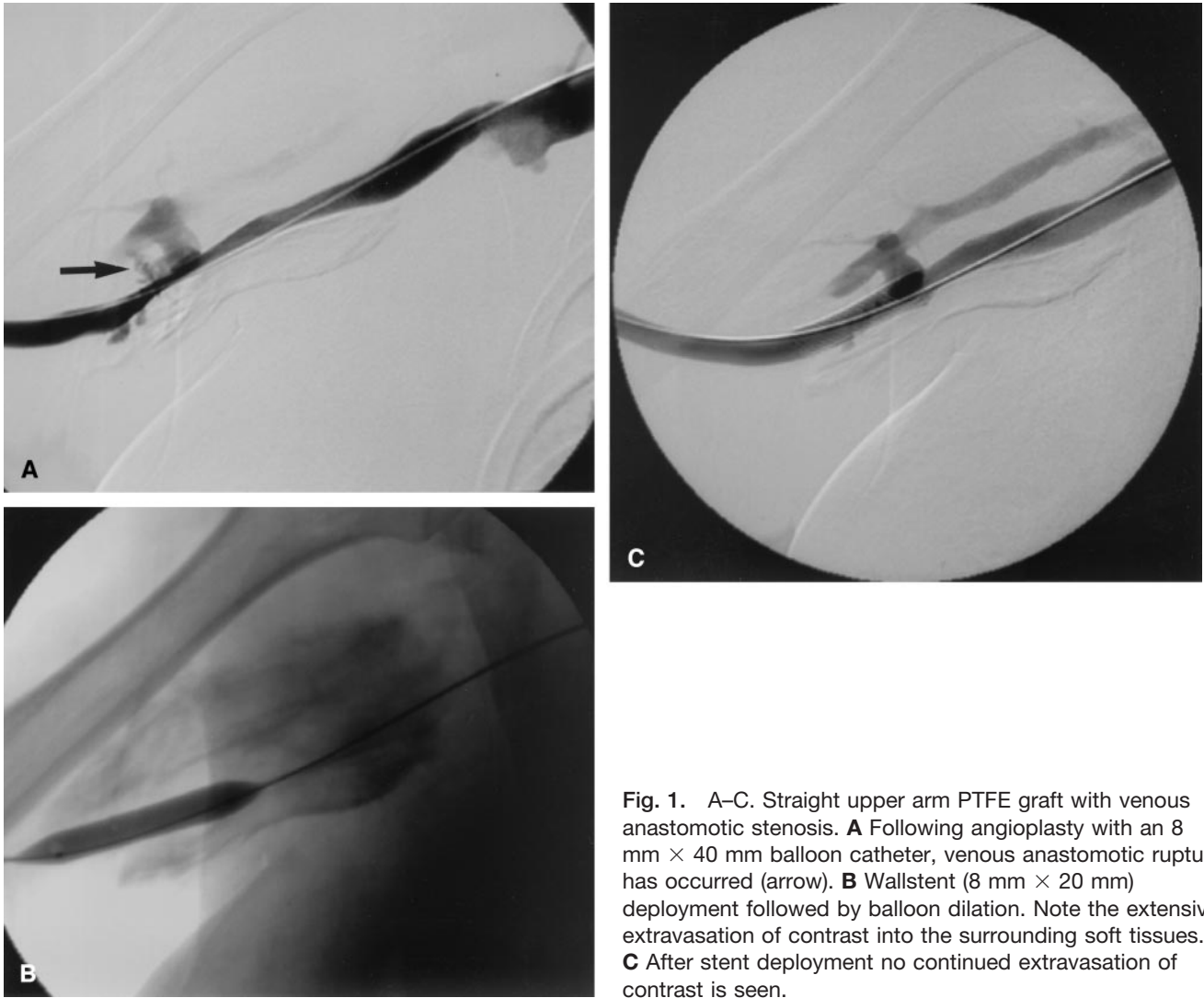


Fig. 1. A–C. Straight upper arm PTFE graft with venous anastomotic stenosis. **A** Following angioplasty with an 8 mm × 40 mm balloon catheter, venous anastomotic rupture has occurred (arrow). **B** Wallstent (8 mm × 20 mm) deployment followed by balloon dilation. Note the extensive extravasation of contrast into the surrounding soft tissues. **C** After stent deployment no continued extravasation of contrast is seen.

function when conservative measures failed. Rupture was recognized as extravasation of contrast beyond the margins of the out-flow vein, vessel wall irregularity and persistent contrast opacification of the adjacent soft tissues. Patients ranged in age from 56 to 78 years with a mean age of 67 years. Two grafts were loop grafts, seven grafts were straight grafts.

Prior to initiation of therapy, written informed consent and intravenous access was obtained. Midazolam (Versed; Roche Pharmaceuticals, Nutley, NJ, USA) and fentanyl citrate (Abbott Laboratories, Abbott Park, IL, USA) were used as needed for conscious sedation. No intravenous antibiotics were given. Access was achieved using a 19 gauge single wall vascular access needle. Puncture sites were anesthetized with 1% lidocaine hydrochloride (Abbott Laboratories, Abbott Park, IL, USA). Direction of puncture was directed towards the venous anastomosis. A 6 Fr Check-Flo Performer sheath (Cook, Bloomington, IN, USA) was then placed and access across the venous anastomotic stenosis was obtained with a 0.035 inch Benston wire or an angled 0.035 inch Glidewire (Terumo, Somerset, NJ). Angioplasty was performed for any venous anastomotic stenosis identified during angiography which was greater than 50% stenosed or had a systolic pressure gradient greater than 10 mmHg. Balloon angioplasty was performed with

noncompliant 7 mm × 40 mm and 8 mm × 40 mm balloon catheters. The balloon catheters used were Ultrathin, BlueMax (Boston Scientific, Natick, MA, USA) and Centurian (Cook, Bloomington, IN, USA), which were inflated with the aid of mechanical inflation devices. The balloon catheters were inflated to the point of resolution of the stenosis or maximum rated burst pressure if a waist persisted. Angioplasty was performed until <30% residual stenosis persisted and/or <10% systolic pressure gradient. Heparin was administered at the discretion of the treating interventional radiologist, with three patients received 4000 IU of heparin intravenously prior to dilation. When rupture occurred, the decision to place a stent at the site of rupture was at the discretion of the radiologist performing the procedure. In all cases, stents were placed for continued significant bleeding from the rupture site, associated with poor antegrade flow or loss of palpable thrill in the graft, not controlled with conservative measures (Fig. 1). The 6 Fr sheath was upsized for a 7 Fr sheath to accommodate the stent delivery system. Stent deployment and repeat angioplasty was performed in an expedient manner to reduce further extravasation. All stents placed were Wallstents; six stents were 8 × 40 mm, the remaining three were 8 × 20 mm, 8 × 60 mm and 10 × 42 mm. Single stents were placed for each rupture. In five cases, balloon

dilatation of the deployed stent was performed for optimal expansion. Puncture site hemostasis was obtained with digital compression and, after 1999, using a modified purse-string suture technique [8]. All cases were performed on an outpatient basis. No patients were placed on anticoagulants after the procedure.

Clinical success was defined as re-establishment of normal dialysis for at least one session. Follow-up information regarding each patient was from patient charts maintained by a dedicated dialysis nurse coordinator. In addition, when poor flows were obtained during hemodialysis, Transonic examination (Transonic Systems, Ithaca, NY, USA) or grafts was performed to determine whether possible re-intervention was required. Primary, assisted primary and secondary patency were defined in accordance with the published guidelines of the Society of Cardiovascular and Interventional Radiology, and included initial failures based on "intent to treat" [9, 10]. Patency estimates were calculated using the Kaplan-Meier life table method with calculation of the standard error. One patient was lost to follow-up. Average follow-up was 13 months. Institutional Review Board approval was obtained for this retrospective study.

Results

Technical success of stent placement was 100%. Clinical success was also 100%. In all cases, leakage of contrast into the surrounding soft tissues resolved immediately after stent deployment. The primary patency rates (\pm SE) of stents placed at the venous anastomosis were 88% (12%) at 30 days, 63% (17%) at 90 days, 33% (18%) at 180 days and 17% (15%) at 360 days. The secondary patency rates (\pm SE) were 89% (11%) at 90 days, 76% (15%) at 180 days and 69% (23%) (6 stents patent) at 360 days. During follow-up, one graft was removed because of infection 3 months following stent placement, one patient died and another was lost to follow-up. The remaining six stented grafts remain patent at most recent follow-up. A single minor complication of a puncture site hematoma occurred (11%) with no major complications. No clinical sequelae requiring further intervention (nerve palsy, graft compression, compartment syndrome, pseudoaneurysm formation) related to hemorrhage into the surrounding soft tissues were noted. Mean procedure time was 95 min (SD 43 min). No patients were admitted for continued observation.

Discussion

Percutaneous management of dysfunctional dialysis grafts has now received widespread acceptance as a primary form of treatment [11, 12]. As described in multiple previous studies, the most common site of stenosis is at the venous anastomosis in hemodialysis grafts [1, 3, 13]. Accepted percutaneous therapy is balloon angioplasty of this region with 6, 7 or 8 mm diameter balloon catheters. In a small subset of treated grafts, rupture of the anastomosis does occur where large uncontrolled ruptures can lead to loss of the dialysis graft.

In our limited experience, in most cases we were able to predict when venous rupture was likely to occur. Angiographically, balloon expansion did not occur progressively and in some cases we also noted a focal web-like stenosis prior to rupture. When rupture occurred, there was sudden relief of the waist of the balloon with a "popping" sensation traveling down the shaft of the balloon catheter. Patients also experienced sudden brief pain in the region of angioplasty. Reported rates of rupture are 2–5% [1, 5, 7, 14–16]; we observed a rate of 2.1% at the venous anastomosis.

When rupture does occur, treatment can include reversal of anticoagulation, observation, balloon tamponade, stent deployment or intentional graft thrombosis. The last option is considered least desirable since it results in loss of previous venous capital, and necessitates the placement of temporary access and planning for alternate permanent access. Stent deployment is hypothesized to be effective and safe in cases of rupture by providing a smooth low-resistance channel for blood flow [4, 5, 7, 14]. Continued bleeding through the interstices of the stent is minimal, as observed in previous studies [4–6, 14]. Although stent placement at the site of rupture is a recognized effective therapy, few papers discuss the patency of stents placed in this location. In a study by Raynaud et al. [6], 19 ruptures were identified at the venous anastomosis of grafts for which Wallstents were placed. However, an additional six ruptures occurred in Brescia-Cimino (BC) fistulae. The patency numbers included stented BC fistulae and two central venous stents with primary and secondary patencies of 48% and 86% at 1 year [6]. Funaki et al. [5] treated 23 patients with venous rupture with Wallstents. Twenty-one ruptures occurred in the peripheral veins [5]. However, within this population, the exact location of stent deployment was not noted. The primary patency of stents was 52% at 60 days, 26% at 180 days and 11% at 1 year, with secondary patency rates of 74% and 65% at 60 and 180 days respectively and 56% at 1 year. In another paper, by Rundback et al. [4], five stents were placed at the venous anastomosis following rupture in PTFE grafts. Mean primary patency was 2.3 months and secondary mean patency was 9.3 months [4]. In another study, 14 stents were placed at sites of venous rupture, with 12 being placed at the venous anastomosis with primary patencies of 63% and 46% at 30 and 90 days. Secondary patency was 85% and 75% at 60 and 180 days [7].

In comparison with previous studies describing stents placed at the venous anastomosis of dialysis grafts, Patel et al. [14] placed Wallstents across 26 unruptured lesions at the venous anastomosis with initial success of 100%. At 3 and 6 months, primary patency was 34% and 27% respectively with secondary patency of 77% and 72% at 3 and 6 months respectively [14]. Our primary patency minimally exceeds that of stents placed at the venous anastomosis for angioplasty failure and peripheral venous rupture [1, 4–6, 17]. Secondary patency is similar to that of stents placed at the venous anastomosis for non-ruptured and ruptured cases [5, 7, 14].

Comparisons among the aforementioned studies are difficult for a number of reasons. Many studies do not report outcomes using standardized methods. Others do not differentiate outcome based on type of dialysis fistula (PTFE graft versus native arteriovenous fistula) or location of treated venous lesions (central versus peripheral). Small sample sizes also limits the statistical significance of many of the studies, including this study.

Although bleeding may continue through the interstices of the stent, the extent of hemorrhage appears to be minimal; the precise explanation for this is not known. Some authors, including ourselves, hypothesize that stent placement allows formation of a low-pressure conduit through which blood can flow rather than extravasating into the surrounding tissues [7, 14], whereas Raynaud et al. [6] suggested four possible mechanisms: stents remove the stenosis caused by surrounding hematoma thereby decreasing pressure within the graft, an intimal flap tacked up by the stent creates a plug, the rupture is tortuous with a stent reapplying the edges, and Wallstents are thrombogenic favoring occlusion at the site of vessel tear. Covered stents are an optional treatment of venous rupture although Wallstents appear to be sufficiently effective and less costly in controlling significant extravasation. Covered stents may have a role in treating persistent bleeding not controlled with uncovered stent deployment [18].

In conclusion, hemodialysis access complicated with angioplasty-induced rupture at the venous anastomosis can be salvaged with placement of Wallstents across the site of rupture. Although the number of Wallstents placed in this study is small, the results do suggest that Wallstents placed at the venous anastomosis following rupture have a primary and secondary patency similar to those of stents placed for reasons other than rupture. Primary patency may exceed that of stents placed in peripheral veins for stenosis.

References

1. Beathard GA (1992) Percutaneous transvenous angioplasty in the treatment of vascular access stenosis. *Kidney Int* 42:1390–1397
2. Vorwerk D, Guenther RW, Mann H, Bohndorf K, Keulers P, Alzen G, Sohn M, Kistler D (1995) Venous stenosis and occlusion in hemodialysis shunts: Follow-up results of stent placement in 65 patients. *Radiology* 195:140–146
3. Turmel-Rodrigues L, Pengloan J, Blanchier D, Abaza M, Birmele B, Haillot O, Blanchard D (1993) Insufficient dialysis shunts: Improved long-term patency rates with close hemodynamic monitoring, repeated percutaneous balloon angioplasty, and stent placement. *Radiology* 187:273–278
4. Rundback JH, Leonardo RF, Poplasky MR, Rozenblit G (1998) Venous rupture complicating hemodialysis access angioplasty: percutaneous treatment and outcomes in seven patients. *AJR Am J Roentgenol* 171:1081–1084
5. Funaki B, Szymiski GX, Leef JA, Rosenblum JD, Burke R, Hackworth CA (1997) Wallstent deployment to salvage dialysis graft thrombolysis complicated by venous rupture: Early and intermediate results. *AJR Am J Roentgenol* 169:1435–1437
6. Raynaud AC, Angel CY, Sapoval MR, Beyssen B, Pagny JY, Auguste M (1998) Treatment of hemodialysis access rupture during PTA with Wallstent implantation. *J Vasc Interv Radiol* 9:437–442
7. Welber A, Schur I, Sofocleous CT, Cooper SG, Patel RI, Peck SH (1999) Endovascular stent placement for angioplasty-induced venous rupture related to the treatment of hemodialysis grafts. *J Vasc Interv Radiol* 10:547–551
8. Simons ME, Clark TWI, Rajan DK (2001) The woggle technique: A new method of suture closure of hemodialysis arteriovenous grafts and fistulas after percutaneous interventions. *J Vasc Interv Radiol* 12(Suppl):S30
9. Gray RJ, Sacks D, Martin LG, Trerotola SO (1999) Reporting standards for percutaneous interventions in dialysis access. Technology Assessment Committee. [see comments]. *J Vasc Interv Radiol* 10:1405–1415
10. Aruny JE, Lewis CA, Cardella JF, Cole PE, Davis A, Drooz AT, Grassi CJ, Gray RJ, Husted JW, Jones MT, McCowan TC, Meranze SG, Van Moore A, Neithamer CD, Oglevie SB, Omary RA, Patel NH, Rholl KS, Roberts AC, Sacks D, Sanchez O, Silverstein MI, Singh H, Swan TL, Towbin RB (1999) Quality improvement guidelines for percutaneous management of the thrombosed or dysfunctional dialysis access. Standards of Practice Committee of the Society of Cardiovascular & Interventional Radiology. *J Vasc Interv Radiol* 10:491–498
11. Anon (1997) NKF-DOQI clinical practice guidelines for vascular access. National Kidney Foundation–Dialysis Outcomes Quality Initiative. *Am J Kidney Dis* 30(Suppl 3):S150–191
12. Eknoyan G, Levin NW, Eschbach JW, Golper TA, Owen WF Jr, Schwab S, Steinberg EP (2001) Continuous quality improvement: DOQI becomes K/DOQI and is updated. National Kidney Foundation–Dialysis Outcomes Quality Initiative. *Am J Kidney Dis* 37:179–194
13. Kanterman RY, Vesely TM, Pilgram TK, Guy BW, Windus DW, Picus D (1995) Dialysis access grafts: Anatomic location of venous stenosis and results of angioplasty. [erratum appears in *Radiology* 1995;196:582]. *Radiology* 195:135–139
14. Patel RI, Peck SH, Cooper SG, Epstein DM, Sofocleous CT, Schur I, Falk A (1998) Patency of Wallstents placed across the venous anastomosis of hemodialysis grafts after percutaneous recanalization. [see comments]. *Radiology* 209:365–370
15. Saeed M, Newman GE, McCann RL, Sussman SK, Braun SD, Dunnick NR (1987) Stenoses in dialysis fistulas: Treatment with percutaneous angioplasty. *Radiology* 164:693–697
16. Glanz S, Gordon DH, Butt KM, Hong J, Lipkowitz GS (1987) The role of percutaneous angioplasty in the management of chronic hemodialysis fistulas. *Ann Surg* 206:777–781
17. Gray RJ, Horton KM, Dolmatch BL, Rundback JH, Anaise D, Aquino AO, Currier CB, Light JA, Sasaki TM (1995) Use of Wallstents for hemodialysis access-related venous stenoses and occlusions untreatable with balloon angioplasty. *Radiology* 195:479–484
18. Sapoval MR, Turmel-Rodrigues LA, Raynaud AC, Bourquelot P, Rodrigue H, Gaux JC (1996) Cragg covered stents in hemodialysis access: Initial and midterm results. *J Vasc Interv Radiol* 7:335–342