Prophylactic Angioplasty of Failing Hemodialysis Shunts

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Prophylactic angioplasty of dysfunctional hemodialysis shunts is a common and relatively straightforward procedure. If left untreated, many stenotic lesions progress to ultimately incite thrombosis and access failure. Angioplasty improves access patency and helps avert thrombosis that can reduce overall access life.

PROCEDURE

Preprocedure

In my practice, patients are most commonly referred to interventional radiology when dysfunction occurs during dialysis. The presence of a stenosis in the absence of a functional abnormality is not an indication for an intervention. It is important to recognize that different anatomical problems lead to different types of dysfunction:

- Poor clearance: inflow > outflow stenosis
- High venous pressures: outflow stenosis
- Pulling clots: inflow > outflow stenosis
- Arm swelling: central vein stenosis
- Inability to cannulate shunt: inflow stenosis
- Increasing compression times: outflow stenosis

Before puncture, the shunt should be evaluated by direct physical examination. Not uncommonly, both the type and location of the lesion can be identified by this

examination. For example, pulsatility of a graft typically indicates a venous outflow stenosis, whereas a weak thrill suggests an arterial inflow problem.

Puncture

After subcutaneous lidocaine is administered, the access should be punctured at a location and in a direction chosen to address the suspected problem. As a general rule, if both the physical examination and history are unhelpful (which is rare), grafts and upper arm fistulas are punctured in the arterial limb, with the needle directed toward the venous anastomosis, and forearm fistulae are punctured in the dilated segment of vein, with the needle directed toward the arterial anastomosis. These puncture sites enable the most common problems to be corrected in each type of shunt. I use a Micro-puncture set (Cook, Bloomington, IN) for access. Occasionally, in poorly maturing fistulas, venipuncture may prove difficult. In this instance, using ultrasound guidance to localize veins or a tourniquet to distend veins may be helpful.

Wire Purchase

A 0.018-inch guidewire is advanced into the vein and the needle is exchanged over this guidewire for coaxial 3 and 5F dilators included in the kit. The 0.018-inch guidewire and 3F dilator are removed. Fistulography can then be performed through the 5F dilator or (in the case of a

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fistula when the dilator won't cross the arteriovenous anastomosis), this can be exchanged for a short 5F catheter.

Fistulography

A fistulogram is then performed by injecting a 1:1 mixture of contrast and saline (Fig. 1). The entire shunt and venous outflow to the heart should be imaged. The study is then evaluated and intervention planned. I do not routinely use heparin for these procedures. Per Dialysis Outcome Quality Initiative guidelines, all stenoses > 50% with concomitant functional abnormalities should be treated.

Angioplasty

If angioplasty is indicated, an appropriate diameter balloon is chosen. As a general rule, I start with a 5-mm diameter balloon in arteriovenous stenoses in forearm fistulas and a 7-mm diameter balloon in anastomotic venous stenoses in grafts. I typically perform most interventions without a sheath except in shunts with a cephalic arch stenosis. In this intervention, I maintain wire access across the lesion due to a propensity for rupture or spasm at this site.

I employ high-pressure balloons (e.g., Blue Max; Boston Scientific, Natick, MA) for all interven-

tions. I perform a single dilation for ~30 seconds to completely efface the lesion and repeat fistulography. As noted earlier, I do not routinely maintain wire access across the lesion unless I am concerned about a rupture or vasospasm, which is most common for cephalic arch lesions. If a residual stenosis persists, I perform a longer dilation of ~1 to 2 minutes. If I am unable to efface the waist of the lesion, I use ultra-high-pressure balloons (Centurion; Bard, Covington, GA) to attempt to efface the lesion. If this fails, I use a cutting balloon (Peripheral Cutting Balloon; Boston Scientific, Natick, MA).

After angioplasty, fistulography is repeated. One common mistake reflecting inexperience is to treat several lesions over a protracted time (<5 minutes) without performing intervening fistulography. It is important to perform fistulography shortly after angioplasty to detect venous rupture that can otherwise be overlooked until a large hematoma has developed. Pullback pressure measurements are obtained across equivocal residual stenoses. I consider a gradient > 10 mm as evidence of a "significant" residual stenosis. Further treatment of this type of lesion is predicated on past history. If it is the first time the lesion is dilated, I may refrain from treating the lesion with a stent and give the patient a short trial at dialysis. If it is a rapidly recurring lesion, I more likely use a stent to treat the affected area.

Figure 1 Prophylactic angioplasty of elastic stenosis in dysfunctional left arm arteriovenous graft. (A) Initial fistulogram shows high-grade venous anastomotic stenosis (black arrow). Note collateral venous drainage (white arrow). (B) Fluoroscopic image shows balloon angioplasty using a 7 mm × 4 cm high-pressure balloon. (C) Postangioplasty fistulogram shows minimal improvement in stenosis (dashed black arrow). (D) Fluoroscopic image shows repeat prolonged balloon angioplasty of lesion using 8 mm × 3 cm high-pressure balloon catheter.

Figure 1 (Continued) (E) Post-repeat angioplasty fistulogram shows slight improvement (black arrow) with continued outflow via collateral veins. (F) Fluoroscopic image shows 8 × 40 mm self-expanding stent deployed across stenosis. (G) Final fistulogram after stenting shows alleviation of stenosis.

Stent Insertion

When stents are used, as a general rule, the shortest stent that can be employed is chosen. The stented region should be limited to the affected lesion as much as possible. It is vitally important not to interfere with future surgical options when stents are inserted. I reserve stents for the following situations:

- Venous rupture refractive to prolonged balloon dilation: Self-expanding bare metal stents are sufficient to control bleeding in virtually all cases.
- Elastic peripheral stenoses: Lesions that can be effaced but immediately recur after balloon deflation are treated using short self-expanding bare metal nitinol stents.
- Recanalized occlusions: Occlusions that are recanalized but highly stenotic can be treated using bare metal self-expanding nitinol stents.
- Elastic central venous stenoses: Stents in the central veins are often slightly longer than those used in the periphery due to the need to have sufficient anchoring at the lesion site. It is important not to cross and thereby “jail” the internal jugular vein when placing subclavian vein stents, the subclavian vein when placing a cephalic arch stent, or the superior vena cava when placing a brachiocephalic vein stent.

Hemostasis

After the procedure, the catheter is removed and hemostasis is achieved. Most commonly, I use manual

compression with a purse-string or miniature tourniquet in rare cases.

DISCUSSION

Most investigators believe that a screening program that identifies failing shunts at dialysis and treats the underlying cause leads to prolonged patency of access sites. However, this point is not universally accepted, and several published reports refute the notion. Nonetheless, in general, most would agree that prophylactic angioplasty when used appropriately is a valuable intervention for patients with hemodialysis shunt dysfunction. The procedure is straightforward and easily done on an elective outpatient basis. Complications are nearly always manageable in the interventional radiology suite without a hospital admission.

Several complications may occur during prophylactic angioplasty procedures, including rupture, allergic reaction to contrast, infection, and thrombosis. All of these are extremely rare except venous rupture, which occurs in ~2 to 5% of procedures. In my experience, angioplasty-induced ruptures are most common in long segment (> 3 cm) high-grade stenoses, recanalized occlusions, and in the cephalic arch. Rupture is recognized by pooling and extravasation of contrast after angioplasty and usually accompanied by pain and swelling at the site of dilation. Prolonged balloon tamponade (3 to 5 minutes) controls many ruptures but continued bleeding should be treated with a stent. In my experience, bare metal stents suffice in nearly all cases, although some of my colleagues

use covered stents for this intervention. It is crucial to have any and all more central stenoses adequately dilated to enable blood to egress the injured area as quickly as possible. Graft thrombosis may rarely occur in very high-grade lesions when prolonged balloon dilation is pursued. In these cases, it may be warranted to use a low dose of heparin (e.g., 3000 IU) to help preclude this complication. Other complications, such as contrast reaction, pulmonary embolism, or graft infection, are very rare.

SUGGESTED READINGS

National Kidney Foundation. Kidney Disease Outcomes Quality Initiative. www.kidney.org/professionals/KDOQI/guideline_up_HD_PD_VA/index.htm

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