Problematic Declots: Complications and Irritations

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ABSTRACT

Percutaneous declotting of thrombosed dialysis grafts is performed using a variety of techniques with both mechanical devices and pharmacologic agents. Untoward events are uncommon but do occur. This article summarizes common complications and pitfalls encountered with percutaneous graft declotting. Management options are reviewed with an emphasis on those problems that can be successfully managed in the interventional radiology suite.

KEYWORDS: Percutaneous declotting, complications, thrombolysis, hemodialysis graft

Objectives: Upon completion of this article, the reader should be able to (1) summarize common complications associated with percutaneous graft declotting and (2) describe appropriate courses of management.

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Percutaneous declotting of synthetic arteriovenous dialysis grafts can be performed using a variety of techniques with clot dissolving drugs or mechanical devices. All methods are used successfully and the most common reason for choosing one over the others is simply personal preference. The author prefers to use thrombolytic agents because pulmonary embolization occurs with any technique (particularly with technically difficult declots) and thrombolytic drugs continue to lyse both thrombus within the graft and embolized clot in the lungs. Despite this preference, the author disputes the notion that there is one best method of graft declotting. Any technique that removes the entire clot burden from a graft and corrects the underlying etiology of graft

thrombosis is as good as any other. Similarly, any technique performed poorly is equally as bad as any other technique. In this author's opinion, debate about different approaches is largely an academic exercise and individual interventionalists should employ whatever method they find most effective.

This article summarizes common complications and additional irritations associated with graft declotting that might be handled in the angiography suite. Some of these complications reflect inexperience. As an academic radiologist in a busy fellowship training program, the author has dealt with complications that probably rarely occur in the hands of more seasoned interventionalists. As with any untoward event, it advisable to take

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appropriate precautions to prevent the complication rather than to deal with the unhappy ramifications. Nonetheless, complications develop in any practice and every interventionalist should understand how they might occur and be prepared to deal with them.

ROUTINE DECLOTTING PROCEDURE

Declotting procedures can be performed in a slightly different manner by each interventionalist. As a point of reference, the author's typical procedure is outlined below.

1. Access graft in venous limb and cross venous anastomosis. Inability to cross anastomosis is the most common cause of declotting failure. If one is unable to cross the anastomosis, the procedure is terminated.
2. Administer 3000 to 5000 U heparin into central veins. (Regardless of technique, the author strongly recommends concomitant heparinization during declotting; anticoagulation maintains flow in grafts during suboptimal conditions and prevents propagation of clot that is embolized to the lungs or outflow veins.)
3. Perform central venogram. If central vein occlusion is present, treat this lesion prior to declotting. Declotting a graft in a patient with an ipsilateral central venous occlusion usually results in acute arm swelling.
4. Administer lytic agent into graft (2 to 4 mg recombinant tissue-type plasminogen activator [rt-PA], 0.5 units recombinant plasminogen activator [r-PA], or 500,000 U urokinase).
5. Access graft in venous limb ~5 to 8 cm above the first puncture with needle directed toward arterial anastomosis.
6. Cross arterial anastomosis.
7. Perform inflow arteriogram. Note patency of distal arteries and size and position of inflow feeding artery. Administer thrombolytic agent into arterial limb of graft.
8. Perform venography and dilate all venous lesions. Macerate any clot still present on venous side of graft.
9. Pull arterial plug.
10. Macerate intragraft clot if present.
11. Dilate any additional lesions and perform pullback pressure measurements for equivocal results.

GENERAL STRATEGY FOR UNTOWARD EVENTS

When dealing with most complications, it is advisable to have at least one additional assistant who is scrubbed and present during the procedure. Do not "go it alone" and do not panic. In a worst-case scenario, simply inflate an

occlusion balloon at the arterial inflow in the graft to stop blood flow. Do not hesitate to call for additional help when necessary.

PULLBACK PRESSURE MEASUREMENTS

Occasionally, it may be difficult to ascertain whether or not angioplasty has been adequate. If collateral veins fill with contrast before angioplasty but not after, dilation was probably sufficient. If collateral veins were not present before angioplasty and a residual stenosis persists, the author routinely performs pullback pressure measurements.¹ As a rule of thumb, pressure measurements are obtained in any instance where postangioplasty venography is equivocal and fellows are encouraged/coerced to do the same. Most interventional radiologists use pressure measurements to guide arterial interventions but paradoxically, few use pullback pressures to guide dialysis-related interventions. Such measurements are indispensable, especially when declotting upper arm or leg grafts (Fig. 1) or dealing with early rethrombosis. A mean gradient of 10 mm Hg is considered by this interventionist to be indicative of a significant stenosis and such a lesion is treated accordingly.

CONTRAST ALLERGY

A patient with a contrast allergy can be pretreated with methylprednisolone (32 mg orally 2 and 12 hours prior to the procedure) and diphenhydramine (50 mg orally 1 hour prior to the procedure). Alternative contrast agents such as gadolinium or carbon dioxide work very well and are easily applicable to graft declotting. In the author's opinion, none provide the image contrast of conventional contrast; for this reason, pullback pressure measurements are routinely used after declotting when alternative contrast agents are used in the author's institution.

ACCESS LOSS

Accidentally pulling a sheath or catheter out of a partially declotted graft is more of an annoyance than anything else. When this occurs, it is best to have an assistant compress the arterial inflow and then recannulate the puncture site using the stiff (back) end of a hydrophilic guidewire and a 4- or 5-French sheath. Alternatively, an 0.018-in. wire and coaxial dilator from a micropuncture kit (which is often already on the back table) can be used.

BLEEDING FROM PRIOR PUNCTURES

Sometimes, after flow has been re-established within a graft, old dialysis puncture sites begin to bleed or even spray like a geyser. This usually indicates that the venous outflow stenosis that incited thrombosis has not yet been

Figure 1 Utility of pullback pressure measurements. (A) Venogram shows stenosis at venous anastomosis of left thigh dialysis graft. (B) Venogram after angioplasty with 7-mm-diameter angioplasty balloon shows improved blood flow. A pullback pressure measurement revealed a gradient of 15 mm Hg. (C) Fluoroscopic image shows repeated dilation using an 8-mm angioplasty balloon. (D) Final venogram after 8-mm angioplasty shows a widely patent anastomosis; pullback pressure measurement was 3 mm Hg.

dilated and is causing high venous pressure within the graft. Blood assumes the path of least resistance through old puncture sites. Parenthetically, this is one of the reasons the author dilates the venous outflow prior to dislodging the arterial plug to re-establish flow into the graft. Often simply dilating the outflow will reduce pressure enough in the graft to facilitate hemostasis. If this does not work, performing a simple purse-string suture on the bleeding site will stop hemorrhage. If

bleeding is especially brisk, it is helpful to inflate a 6-mm angioplasty balloon near the arterial inflow of the graft while performing the purse-string closure.

CLOTTING ANEURYSMAL SEGMENTS

Adherent clot in aneurysms is a common problem when declotting native arteriovenous fistulae but also may hinder declotting of older synthetic grafts that have

begun to degenerate. Sometimes the remaining clot will act in a ball-valve fashion to incite rethrombosis. In other instances it serves as a nidus for rapid rethrombosis.

When using a mechanical thrombectomy device, it is best to position the tip of the device within the aneurysm and perform external massage of the aneurysm to free the clot and to enable the device to contact thrombus. When using thrombolytic agents, occlusion balloons in conjunction with external massage often will succeed. On rare occasions, stents have been used to trap residual thrombus with mixed results, but this solution is not advisable for routine use. Recent articles have reported the use of covered stents for this purpose but long-term results are unknown.²⁻⁴

CLOT ADHERENT TO SHEATHS

Clot at puncture sites adjacent to sheaths often resists lysis. External massage occasionally accompanied by simultaneously removing the sheath or angioplasty balloon catheter over a guidewire usually will macerate thrombus and promote increased blood flow through the segment.

TIGHT VENOUS STENOSES

It is not uncommon to encounter venous lesions that cannot be dilated successfully using a conventional angioplasty balloon inflated to 12 atm. Many interventionalists routinely use high-pressure angioplasty balloons in all declots for this reason. In the author's experience, a high-pressure balloon such as a Blue Max (Boston Scientific, Natick, MA) inflated to 18 to 20 atm will dilate more than 90% of all venous stenoses. Some stenoses are refractory to even high-pressure angioplasty balloons. Several novel techniques have been reported to deal with these lesions, including using a 20-gauge needle to percutaneously puncture the stenosis to weaken the stricture and facilitate angioplasty or using a guide wire in tandem with an angioplasty balloon to simulate the action of a cutting balloon.⁵ A new very high pressure balloon (Conquest Balloon, Bard, Inc., Covington, GA) can be inflated to 30 atm, but even this balloon will not dilate all lesions. Cutting balloons, currently used for coronary angioplasty, with some off-label use in infrapopliteal angioplasty, should provide another alternative when they become widely available.

VENOUS OCCLUSIONS

Venous occlusions are commonly encountered in practice. The author's usual approach is to attempt to cross the obstruction using a multipurpose angled 5-French catheter and a stiff angled hydrophilic guidewire. Sometimes to improve mechanical advantage, it is helpful to insert a long vascular sheath to the level of the stenosis to

provide more of a "backbone" to push. In rare instances with central venous occlusions, it might be helpful to approach the lesion from a femoral approach. The success rate of crossing an occlusion typically depends on the chronicity of the lesion, with acute occlusions having the highest success rate. In the author's experience, many occlusions can be negotiated and dilated successfully but the long-term prognosis after treatment is suboptimal because they have a tendency to recur. Most lesions also require some form of stenting after angioplasty (Fig. 2). Covered stents might prove useful for this purpose. As with any central venous stent, it is important to avoid positioning the stent across venous branch points (e.g., a stent should not be placed across the confluence of subclavian vein and internal jugular vein or the internal jugular vein will be "caged," limiting its future use of a catheter).

INTRAGRAFT STENOSES

Intragraft stenoses are common in older grafts and most often can be successfully dilated using high-pressure angioplasty balloons. Occasionally, elastic lesions are encountered. At our institution, these are treated using stents,⁶ although other institutions routinely refer these patients for surgical revision. If using stents, it is best to either avoid stenting an area of the graft used for punctures, to instruct the patient and dialysis staff not to puncture the stent, or to use stents with larger interstices.

VENOUS RUPTURE

Venous rupture is an unusual but not a rare event, particularly when dilating long segment outflow strictures or occluded segments. Rupture also is more common in recently inserted (< 1 month old) grafts that have thrombosed. The first course of action is prolonged (2 to 5 minutes) balloon tamponade. If this is unsuccessful, any metallic stent deployed across the venous rent will solve the problem (Fig. 3). A covered stent will also suffice but is unnecessary. In the author's experience, any uncovered stent *always* works even with full anticoagulation and in a systemic lytic state. Presumably, after a stent has been deployed, the path of least resistance for blood is into the more central veins rather than lateral extravasation through the rupture site. If there is continued extravasation after stent deployment, it indicates a more central stenosis or occlusion causing increased venous pressure that must also be dilated. Stents deployed for this indication have patencies similar to stents used for other dialysis-related venous stenoses.⁶⁻¹⁰

VENOSPASM

Venospasm is most commonly encountered when the cephalic vein is used as the venous outflow. The

Figure 2 Recanalization of cephalic vein occlusion. (A) Initial venogram shows occlusion of the cephalic vein and numerous collateral veins in the upper arm. (B) Venogram after recanalization and balloon angioplasty shows patent but narrowed segment. (C) Venogram after stenting shows markedly improved blood flow through previously occluded segment.

propensity for venospasm in this vein is not entirely clear. Given that this vein is superficial, it probably constricts and dilates to accomplish thermoregulation. In addition, if injured it must constrict to prevent hemorrhage. For whatever reason, most interventionalists empirically recognize that the cephalic vein is prone to venospasm when irritated. It is best to avoid this problem by using gentle techniques (soft-tipped floppy guidewires such as Bentson wires and small angioplasty balloons) and keeping the arm warm during procedures. Avoid repeatedly crossing lesions and overmanipulation of wires and catheters in this vein. If venospasm occurs, do *not* attempt to dilate the vein with an angioplasty balloon—this results in venous rupture as often as it is successful. It is best simply to wait several minutes for spasm to subside. The author has not had good success using vasodilators, although others have reported using them for this purpose.

ARTERIAL RUPTURE

Arterial rupture is a very rare event. The author has seen it occur in two circumstances. First, if inflow arteriography is not performed prior to dislodging the arterial plug using an angioplasty balloon, rupture can occur if the balloon is not properly matched to the size of the inflow artery. This is best managed by surgical repair. To minimize hemorrhage, an occlusion balloon should be inflated above the site of rupture. Second and more uncommonly, angioplasty of the inflow artery might

cause anastomotic rupture. This can be managed successfully using an uncovered stent in similar fashion to a venous rupture if flow has been re-established in the graft. Otherwise, a covered stent might prove useful.

ARTERIAL EMBOLIZATION

This probably occurs more often than realized and in my opinion should not be aggressively treated unless symptomatic because further attempts at treatment might simply aggravate the situation. Embolization typically occurs when crossing the arterial anastomosis or dislodging the arterial plug into the graft. This plug is quite resistant to thrombolytic agents and is usually beyond the safe reach of thrombolytic devices (Fig. 4). The best technique to deal with symptomatic emboli is the back-bleeding technique reported by Trerotola et al.¹¹ This is a variant of a tried-and-true surgical technique and works by reversing blood flow at the arterial anastomosis. After flow has been re-established into the graft, an occlusion balloon is inflated in the radial artery above the arterial anastomosis. This promotes antegrade flow to the hand via the ulnar artery and retrograde flow up the radial artery into the low-pressure graft. Retrograde flow carries the arterial plug into the graft and to the lungs. Exercising the hand and massaging the clot upward toward the graft facilitate the procedure. In some cases, clot removal is refractory to all percutaneous efforts and vascular surgeons might be needed to remove embolized thrombus surgically.

Figure 3 Venous rupture treated with an uncovered stent. (A) Initial venogram shows long-segment stricture of the axillary vein. (B) Fluoroscopic image shows inflated 7-mm angioplasty balloon. (C) Venogram following angioplasty shows active extravasation indicating venous rupture. (D) Venogram after stent deployment shows rapid antegrade flow without evidence of extravasation.

Figure 4 Arterial embolization. (A) Initial angiogram obtained near the arterial anastomosis shows occlusion of the brachial artery by an embolus at the level of the elbow. (B) Angiogram after back-bleeding technique shows resolution of embolus.

EARLY RETHROMBOSIS

Grafts that rethrombose quickly (within 2 weeks) after initial declotting should be re-treated using percutaneous techniques. In the author's opinion, the only exception to this rule is when rethrombosis is caused by a lesion that was recognized at the time of initial declotting and is not amenable to percutaneous treatment. Commonly, rethrombosis is caused by a stenosis that was undetected at the time of initial declotting.¹² The author has also seen "delayed" elastic lesions (i.e., slow recoil over several minutes) cause rethrombosis. When appropriately treated, these grafts will have acceptable patencies. The author strongly recommends obtaining pullback pressures from the central veins to above the arterial anastomosis at the time of second declotting to identify missed lesions. As stated above, any gradient of 10 mm Hg is indicative of a significant stenosis.

PROTRACTED BLEEDING FROM PUNCTURE SITES AFTER DECLOTTING

After successful declotting, patients often remain anticoagulated in a persistent lytic state. Simply pulling sheaths and holding pressure on puncture sites is a

poor and sanguinary option. There are several means to deal with this problem. At our institution, the vast majority of patients are immediately dialyzed after declothing on-site. Therefore, dialysis sheaths are inserted at the puncture sites in the interventional radiology suite and patients are sent to dialysis with sheaths in place. These sheaths are then used for dialysis and removed after dialysis when coagulation factors have normalized, enabling hemostasis. Alternatively, purse-string sutures can be used and are nearly always successful at achieving rapid hemostasis.^{13,14} We use a minitourniquet to control the tension on the suture that also allows pain-free removal.¹⁵ An additional caveat is to avoid protamine reversal of heparin in any patient who has previously received neutral protamine hagedorn (NPH) insulin because these patients might have sensitivity to protamine, leading to anaphylaxis.

SUMMARY

In summary, the vast majority of untoward events occurring during routine graft declothing can be managed successfully in the interventional radiology suite. However, it is important recognize that some complications will require additional assistance and to remember that one of the hallmarks of any good physician is one who knows when to call for help.

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