Techniques in Vascular and Interventional Radiology

Complications in Percutaneous Dialysis Interventions: How to Avoid Them, and How to Treat Them When They do Occur

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Because of the increasing prevalence of end-stage renal disease, more percutaneous interventions are being performed. They serve an important role, allowing for restoration of access function, which is achieved with high level of technical success. However, complications are inevitable during any types of procedure, and percutaneous dialysis interventions are no exception. To provide safe and effective care these patients need, anyone performing endovascular dialysis interventions needs to understand the possible complications, how they can be avoided, and how they can be addressed if they are to occur. Topics in this article include complications seen while intervening on the thrombosed access, complications of angioplasty, potentially devastating complications of central venous interventions, and complications of dialysis catheter placement. Further, patients with end-stage renal disease are generally sicker than the average patient, usually afflicted by multiple comorbidities and are therefore more complicated from a medical perspective. This places them at higher risk for acute cardiopulmonary decompensation or arrest than any other interventional radiology patient subset. As result, we also briefly review general medical complications in this population.
Tech Vasc Interventional Rad 20:58-64 © 2017 Published by Elsevier Inc.

KEYWORDS Hemodialysis complications, venous rupture, declotting complications, hemodialysis catheter complications

Introduction

Chronic kidney disease is a major health care issue with an estimated 670,000 patients with end-stage renal disease (ESRD) in the United States alone. Given the sheer number of hemodialysis access interventions, a myriad of associated complications during endovascular procedures are inevitable. Complications of hemodialysis interventions range from those minor in nature, such as an access site hematoma, to disastrous ones that can result in access loss, limb loss, or death.[1] A thorough understanding of each of the various types of fistulas and grafts is imperative, as each presents separate possible pitfalls for the proceduralist.[2]

Understanding the potential complications that may arise during interventions for hemodialysis access stenosis and occlusions, how to avoid them, and how to treat them is of paramount importance given that patients with ESRD are usually ill with multiple additional comorbidities and an established baseline higher risk of all-cause mortality.[3-5] Therefore, this article aims to clarify the various complications associated with endovascular interventions in dialysis access, including a brief review of complications seen during declotting of access (previously discussed more thoroughly in the article entitled "Endovascular Salvage of the Thrombosed Dialysis Access"), angioplasty, and hemodialysis catheter placements. It also addresses potential general intraprocedural complications in patients with ESRD, ways to avoid them and treat them.

Complications of Declot

Endovascular declot of the thrombosed access may lead to many potential complications, including arterial embolism, pulmonary embolism, paradoxical embolism, and vessel disruption. Incidence of arterial embolization using percutaneous

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 1089-2516/13/$-see front matter © 2017 Published by Elsevier Inc.
http://dx.doi.org/10.1053/j.tvir.2016.11.009

thrombolysis ranges from 0%-6.3%.[6] Luckily, with strict adherence to proper technique, this complication can be avoided. The operator should avoid unnecessary manipulation of wires and catheters near the arterial anastomosis that may result in dislodgement of the arterial plug. For example, during placement of the retrograde vascular sheath, the wire and sheath should never cross the anastomosis.[7] The operator should also refrain from pressurizing the thrombosed access, such as with contrast or saline injection, which can dislodge the arterial plug into the downstream artery. Regardless of the technique used (pharmacomechanical thrombolysis, mechanical thrombectomy, or thromboaspiration), one should commence the declot intervention from the most central aspect of the thrombus, to clear the outflow obstruction, before decompressing the arterial inflow. If performing balloon maceration, it is important to ensure complete deflation of the angioplasty balloon before balloon retraction toward the arterial anastomosis to prevent dragging thrombus into the artery. If symptomatic arterial embolization does occur, multiple therapies can be employed to clear the obstruction including back-bleeding, TPA infusion into the clot, Fogarty embolectomy, thromboaspiration, or surgical embolectomy.[8,9]

Although rare, it is possible that symptomatic and even fatal pulmonary emboli can result from percutaneous declotting, which is thought to be related to both the volume of thrombus burden within the access and the underlying cardiopulmonary reserve.[10-12] Therefore, we favor surgical thrombectomy rather than percutaneous declot in patients with thrombosed mega-fistula (in which >200 cc of thrombus can be contained) or poor underlying cardiopulmonary reserve, such as pulmonary hypertension or severe COPD.

Additionally, caution should be practiced when considering intervention upon a newly created but thrombosed hemodialysis access. Not only is it a relatively futile endeavor owing to poor patency rates[13] but disruption of the fresh anastomoses, a potentially devastating complication may occur.

Complications of Angioplasty

Percutaneous angioplasty is the treatment of choice for access stenosis; technical procedural success is high (85%-95%). The most common complication of percutaneous transluminal angioplasty is venous rupture.[7,14,15] The quality improvement guidelines initially drafted by the Society of Interventional Radiology (SIR) in 1999 recommended that vessel rupture rate be less than 4%.[16] Angioplasty of stenoses within fistulas is more likely to be complicated by venous rupture than in grafts (5.6% vs 2.8%). Certain fistula sites, such as the cephalic arch and the proximal swing segment of the brachial artery to transposed basilic vein fistula, are at increased risk of venous rupture during angioplasty.[15] For the latter site, the etiology of the increased vulnerability is likely related to skeletonization of this segment of vein during transposition, resulting in removal of the vasa vasorum leading to vessel ischemia[15] (Fig. 1). Angioplasty of stenoses of the cephalic arch is known to result in an alarmingly high rate of rupture, 14.9%. This may be secondary to the recalcitrant nature of cephalic arch stenoses necessitating high-pressure and repeated angioplaties.[2,17]

Careful attention to balloon selection is also necessary. Angioplasty balloons should be thoughtfully selected, with 10%-20% oversizing from the targeted normal vessel diameter—usually resulting in upsizing of 1-2 mm.[18,19] Using a balloon more than 2 mm larger than the diameter of the hemodialysis access results in increased risk of vessel rupture.[20] For refractory stenoses, cutting balloons may be used, but have also demonstrated increased risk of vessel rupture in some studies.[20,21]

Angioplasty intentionally causes stretch injury and weakening of the target vessels.[22] It is, therefore, prudent to avoid placing additional stress on the vessel immediately after angioplasty. For example, when dilating multiple sequential venous stenoses, it is advisable to start more central and then work peripherally. If the opposite sequence is taken, after performing angioplasty and weakening a more peripheral vein, central angioplasty will raise intraaccess pressures at the site of recent angioplasty. This pressure could lead to a tear in the weakened vessel. Likewise, one should avoid performing outflow manual occlusion runs to check the results of a more upstream angioplasty. Manual occlusion will in itself raise access pressure at the site of recent angioplasty. With forceful

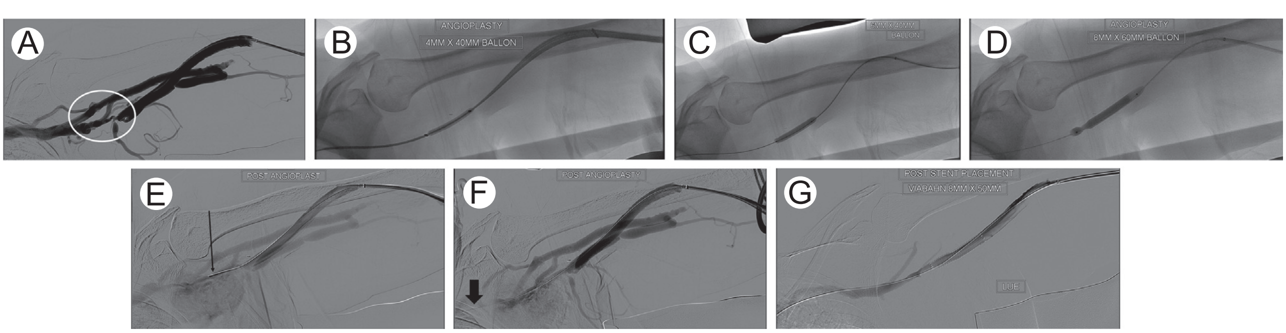

Figure 1 Transposed basilic vein fistula with severe stenosis at the proximal swing segment (A—circle). Serial angioplasties starting from 4 mm diameter balloon to 8 mm diameter balloon, in 2 mm increments, ultimately resulted in frank contrast extravasation (B-D, and E). The wire was not advanced across the venous rupture (E—thin arrow), but was successfully manipulated past the site of extravasation (F—thick arrow) to allow for covered stent placement (G).