The Role of Interventional Radiology in a Comprehensive Hemodialysis Program: The Access Surgeon's View

Daniel Katz, M.D., F.A.C.S.¹

ABSTRACT

The successful hemodialysis program addressing the complex needs of the dialysis patient population employs a collaborative effort among the medical nephrologist, access surgeon, and interventional radiologist. It is imperative that all team members understand the basic tenets of hemodialysis access and afford open and continuous communication to achieve the best results. This monograph will serve to highlight the access surgeon's view of the optimal integration of the interventional radiologist in the development and maintenance of a successful hemodialysis program.

KEYWORDS: Dialysis, access, interventional radiology

More than 300,000 patients in the United States require hemodialysis to treat their end-stage renal disease (ESRD). This results in an annual healthcare expenditure approaching one billion dollars. Specialists caring for this complex group of patients need to develop protocols to optimize patient outcomes and survival.¹ Although regional and individual center practices can vary, a nephrologist, an access surgeon, and an interventionalist remain integral components of a successful hemodialysis program. A clear and thorough understanding of each member's role is imperative to achieve and surpass the outcomes as established by the National Kidney Foundation Kidney Diseases Outcomes Quality Initiative (K/DOQI).² Implicit in such a dialysis program is open and steady communication among the disciplines so that each of the specialists understands the plan for a specific patient and can deal effectively with access complications. This article highlights some of the critical issues that the interventional radiologist

needs to consider to assist optimally the access surgeon in the creation and maintenance of hemodialysis access.

PLACEMENT OF A TEMPORARY TUNNELED OR NONTUNNELED DIALYSIS CATHETER

A permanent vascular access in the form of a fistula or synthetic vascular bridge graft is the preferred means of long-term hemodialysis access. Unfortunately, catheters remain crucial as a bridge to a more desirable access or as the access of last resort. The interventional radiologist frequently is involved in the placement of a temporary tunneled or nontunneled catheter prior to initial evaluation by the access surgeon. The choice of location for catheter placement should be on the patient's dominant side and contralateral to the eventual site for the permanent surgical vascular access. If the patient is right-handed and does not have a left-sided pacemaker, central

Interventional Radiology in Dialysis; Editor in Chief, Peter R. Mueller, M.D.; Guest Editor, Brian Funaki, M.D. *Seminars in Interventional Radiology*, volume 21, number 2, 2004. Address for correspondence and reprint requests: Daniel Katz, M.D., F.A.C.S., 4646 North Marine Dr., 5B, Chicago IL 60640. ¹Chicago, Illinois. Copyright © 2004 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662. 0739-9529,p;2004,21,02,125,127,ftx,en;sir00240x.

catheter, or other evidence of central venous obstruction of the left upper extremity based on history and physical examination, the catheter should be positioned in the right internal jugular vein. Placement of catheters in the subclavian vein should be avoided because they induce a significantly higher incidence of central vein stenoses.^{3,4} Although it is inadvisable to puncture the internal jugular vein high in the neck because this precludes function in a tunneled catheter due to kinking, it might be equally inadvisable to puncture the junction of the right internal jugular and subclavian veins for the insertion site; this location might also lead to higher rates of central stenoses. If a catheter is required because of repeated failed percutaneous treatment attempts of a clotted access, discussion with the access surgeon might dictate placement of the temporary catheter in the jugular vein ipsilateral to the failed access. This maneuver might afford protection of the contralateral extremity for a new access.

ALGORITHM FOR THE SELECTION OF PERMANENT VASCULAR ACCESS

The K/DOQI guidelines strongly promote the creation of autologous fistulae over synthetic bridge grafts if anatomically and technically feasible. Current guidelines recommend an autologous fistula rate of 50% in new patients initiating hemodialysis and 40% in established access patients.² The order of preference for placement of arteriovenous (AV) fistulae in patients with kidney failure who will become hemodialysis dependent is

1. A wrist (radial-cephalic) primary AV fistula
2. An elbow (brachial-cephalic) primary AV fistula
3. A transposed forearm (radial-basilic) primary AV fistula
4. A transposed upper arm (brachial-basilic) primary AV fistula

If the upper arm basilic vein is the only acceptable venous outflow, a forearm loop synthetic bridge graft might be preferable prior to consideration of an upper arm brachial-basilic vein transposition. In the setting of inadequate vein for any autologous fistula, a brachial-axillary graft would be the next alternative.

PREOPERATIVE EVALUATION OF THE HEMODIALYSIS PATIENT

Patients presenting for access evaluation undergo an extensive history and physical that focuses on assessing arterial inflow as well as target venous outflow sites. Prior access attempts and evidence of previous central vein catheterizations are noted because these might portend possible central vein lesions. Chest wall collaterals might

also signify significant central venous stenoses. Manifestations of hand ischemia are documented and investigated further prior to any surgical or interventional procedures.

Preoperative Venous Evaluation

The noninvasive color duplex ultrasound (CDU) of the upper extremity venous system has been shown to be most helpful in assessing the venous system prior to access creation.⁵⁻⁷ The examination primarily seeks to map the course, caliber, and patency of the forearm and upper arm cephalic and basilic veins. The brachial, axillary, subclavian, and jugular veins are assessed for evidence of deep venous thromboses or stenoses. With laboratory, history, or physical stigmata of central venous occlusive disease, most access surgeons would request preoperative diagnostic upper extremity venograms. If central lesions are noted during this study, communication with the access surgeon might result in preoperative percutaneous angioplasty of the offending stenosis prior to operative access placement.

Preoperative Arterial Evaluation

In patients with poor upper extremity distal pulse examinations or other ischemic manifestations, Doppler interrogation is performed of the radial, ulnar, palmar arch, and digital flow. A digital-brachial index < 0.6 is associated with an increased risk of steal syndrome.⁸ These patients might benefit from further assessment with CDU, magnetic resonance angiography, or arteriography.

POSTOPERATIVE SURVEILLANCE AND TREATMENT OF ACCESS DYSFUNCTION

K/DOQI clearly recommends monitoring of autologous as well as prosthetic access function by the nephrologist and dialysis center using a variety of noninvasive means.² Significant abnormalities in these monitors combined with physical examination characteristics should prompt diagnostic AV shuntography for delineation of these lesions. Knowledge of the access configuration as well as examination of the access should guide location and direction of sheath placement for diagnostic and interventional procedures. It is critical that the study accurately demonstrate the complete anatomy from the arterial anastomosis to the superior vena caval-right atrial junction. Multiple studies have demonstrated the benefit of prophylactic percutaneous intervention on long-term patency.⁹⁻¹¹ Prophylactic intervention does not appear to be warranted for stenoses identified in AV grafts and draining veins that are not associated with either a hemodynamic, functional, or clinical abnormality.¹²

The K/DOQI guidelines as well as those endorsed by the Society of Interventional Radiology propose clinical and anatomic success of angioplasty in the setting of stenoses without thrombosis as no more than 30% residual stenosis postprocedure and resolution of physical indicator(s) of stenosis.^{2,13} DOQI recommends that with angioplasty of stenoses in a patent access, a 50% unassisted patency at 6 months should be achieved.² If angioplasty of a graft is required more than twice within 3 months, the patient should be referred for consideration of surgical revision.^{2,13} Although placement of stents for elastic recoil or recurrent stenoses might result in increased patency,^{14,15} their placement should be discussed with the access surgeon prior to deployment if their position might negatively influence subsequent surgical revision.

TREATMENT OF THE THROMBOSED ACCESS

The long-term success of percutaneous treatment of thrombosed grafts is similar, irrespective of the method of thrombus clearance (lytic, mechanical, or surgical). If the access clots more than twice within a 1-month period and the recurrent corrected lesion is re-identified, surgical consultation should be sought.¹³ DOQI recommends a 40% unassisted patency and functionality at 3 months in grafts treated with percutaneous thrombolysis and PTA.² Recent data with percutaneous interventions of thrombosed fistulae have reported most encouraging results as compared with the dismal experience with surgical thrombectomy.^{16,17} The interventional team should work closely with the access surgeon to coordinate rapid declotting of the thrombosed native access and thereby avoid temporary catheters. This position has been endorsed strongly by the Society of Interventional Radiology and DOQI.^{2,13}

CONCLUSION

Effective treatment of the challenging dialysis patient population requires a multidisciplinary approach that combines endovascular with conventional surgical interventions. Communication and coordination of the treatment strategies among all disciplines should result in optimal results.

REFERENCES

1. US Renal Data System. USRDS 2001 Annual Data Report: Atlas of End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2001
2. National Kidney Foundation Kidney Diseases Outcomes Quality Initiative Clinical Practice Guidelines for Vascular Access, 2000. *Am J Kidney Dis* 2001;37(suppl 1):S137–S181
3. Schillinger F, Schillinger D, Montagnac R, Milcent T. Post catheterization vein stenosis in haemodialysis: comparative angiographic study of 50 subclavian and 50 internal jugular accesses. *Nephrol Dial Transplant* 1991;6:722–724
4. Cimochowski GE, Worley E, Rutherford WE, Sartain J, Blondin J, Harter H. Superiority of the internal jugular over the subclavian access for temporary hemodialysis. *Nephron* 1990;54:154–161
5. Allon M, Lockhart ME, Lilly RZ, et al. Effect of preoperative sonographic mapping of vascular access outcomes in hemodialysis patients. *Kidney Int* 2001;60:2013–2020
6. Silva MB Jr, Hobson RW II, Pappas PJ, et al. A strategy for increasing use of autogenous hemodialysis access procedures: impact of preoperative noninvasive evaluation. *J Vasc Surg* 1998;27:302–308
7. Gibson KD, Stehman-Breen CO, Kohler TR. Use of the vascular diagnostic laboratory in improving the success of angioaccess procedures. *Semin Vasc Surg* 2001;14:222–226
8. Goff CD, Sato DT, Bloch PH, et al. Steal syndrome complicating hemodialysis access procedures: can it be predicted? *Ann Vasc Surg* 2000;14:138–144
9. Safa AA, Valji K, Roberts AC, Ziegler TW, Hye RJ, Oglevie SB. Detection and treatment of dysfunctional hemodialysis access grafts: effect of a surveillance program on graft patency and the incidence of thrombosis. *Radiology* 1996;199:653–657
10. Besarab A, Sullivan KL, Ross RP, Moritz MJ. Utility of intra-access pressure monitoring in detecting and correcting venous outlet stenoses prior to thrombosis. *Kidney Int* 1995;47:1364–1373
11. Schwab SJ, Raymond JR, Saedd M, Newman GE, Dennis PA, Bollinger RP. Prevention of hemodialysis fistula thrombosis: early detection of venous stenoses. *Kidney Int* 1989;36:707–711
12. Beathard GA. Percutaneous angioplasty for the treatment of venous stenosis: a nephrologist's view. *Semin Dial* 1995;8:166–170
13. Aruny JE, Lewis CA, Cardella JF, et al. Quality improvement guidelines for percutaneous management of the thrombosed or dysfunctional dialysis access. *J Vasc Interv Radiol* 2003;14:S247–S253
14. Quinn SF, Schuman ES, Demlow TA, et al. Percutaneous transluminal angioplasty versus endovascular stent placement in the treatment of venous stenoses in patients undergoing hemodialysis: Intermediate results. *J Vasc Interv Radiol* 1995;6:851–855
15. Vorwerk D, Gunther RW. Percutaneous interventions in the support of failing hemodialysis fistulae. *Semin Interv Radiol* 1994;11:321–331
16. Turmel-Rodrigues L, Pengloan J, Rodriigue H, et al. Treatment of failed native arterio-venous fistulae for hemodialysis by interventional radiology. *Kidney Int* 2000;57:1124–1140
17. Zaleski G, Funaki B, Kenney S, Lorenz J, Garofalo R. Angioplasty and bolus urokinase infusion for the restoration of function in thrombosed Brescia-Cimino dialysis fistulas. *J Vasc Interv Radiol* 1999;10:129–136