CLINICAL STUDY

Effect of Central Venous Angioplasty on Hemodialysis Access Circuit Flow: Prospective Study of 25 Symptomatic Patients

Yan Yan, MD, Deepak Sudheendra, MD, Mandeep S. Dagli, MD, S. William Stavropoulos, MD, Timothy W.I. Clark, MD, Michael C. Soulen, MD, Jeffrey I. Mondschein, MD, Richard D. Shlansky-Goldberg, MD, and Scott O. Trerotola, MD

ABSTRACT

Purpose: To quantify the effect of central venous percutaneous transluminal angioplasty (PTA) on blood flow within hemodialysis access circuits in patients with symptomatic central venous stenosis (CVS).

Materials and Methods: This prospective study enrolled 30 adults with symptoms attributable to CVS ipsilateral to their access. Five subjects were deregistered because of a lack of CVS (n = 1), untreatable lesion (n = 1), or improper flow measurement timing (n = 3); 25 completed the study (15 men and 10 women; mean age, 62 y; age range, 33–87 y). There were 7 fistulae, 15 grafts, and 3 hybrid access circuits. Mean access age was 675 days (range, 16–3,039 d). Mean CVS symptom duration was 37 days (range, 3–120 d). Peripheral stenoses, if present, were treated first. Intraaccess flow was measured immediately before and immediately after CVS treatment (PTA, stent).

Results: Eleven patients had only CVS, whereas 14 had at least 1 peripheral lesion in addition to CVS. All stenoses underwent PTA. Mean flow rates were 1,424 mL/min (range, 565–2,765 mL/min) before PTA and 1,535 mL/min (range, 598–2,545 mL/min) afterward, yielding a mean increase of 111 mL/min ± 456 or 15% ± 34 (range, −70% to +100%; 95% confidence interval, 1%–29%). Flow was decreased in 9 patients (36%). CVS symptoms were reduced in 24 patients (96%) and recurred in 14 (58%) within a mean of 110 days (range, 7–459 d) after initial PTA. Mean follow-up was 371 days (range, 17–592 d).

Conclusions: CVS symptoms were observed to occur over a wide range of blood flow rates. On average, central venous PTA only mildly increased flow yet reduced symptoms regardless of flow change.

ABBREVIATIONS

CVS = central venous stenosis, IVC = inferior vena cava, KDOQI = Kidney Dialysis Outcomes Quality Initiative, PTA = percutaneous transluminal angioplasty, SVC = superior vena cava

From the Department of Radiology, Division of Interventional Radiology, University of Pennsylvania Medical Center, 1 Silverstein, 3400 Spruce St., Philadelphia, PA 19104. Received December 10, 2014; final revision received March 8, 2015; accepted March 11, 2015. **Address correspondence to** S.O.T.; E-mail: streroto@uphs.upenn.edu

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S.W.S. conducts research with W.L. Gore & Associates (Flagstaff, Arizona), B. Braun (Melsungen, Germany), and Bard Peripheral Vascular (Tempe, Arizona), is a paid consultant for Cook (Bloomington, Indiana) and Bard Peripheral Vascular, and serves on the scientific advisory board for VasoNova (Menlo Park, California). T.W.I.C. is a paid consultant for W.L. Gore & Associates, Bard Peripheral Vascular, and Teleflex (Wayne, Pennsylvania), and receives royalties from Merit Medical (South Jordan, Utah) and Teleflex. M.C.S. is a paid consultant for BTG (West Conshohocken, Pennsylvania), Guerbet (Roissy, France), and Merit Medical, conducts research with Guerbet and BTG, receives royalties from Cambridge University Press (Cambridge, United Kingdom), and is a paid speaker for Sirtex (North Sydney, Australia). S.O.T. is a paid consultant for B. Braun, Bard Peripheral Vascular, Lutonix (Maple Grove, Minnesota), Cook, W.L. Gore & Associates, Medcomp (Harleysville, Pennsylvania), and Teleflex, conducts research with Vascular Pathways (Boca Raton, Florida), and receives royalties from Cook and Teleflex. R.D.S.-G. is a paid consultant for Talecris (Barcelona, Spain) and receives grants from CeloNova (San Antonio, Texas). J.I.M. is a paid speaker for Terumo (Somerset, New Jersey). None of the other authors have identified a conflict of interest.

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Central venous stenosis (CVS), a frequent complication in patients undergoing hemodialysis, can result in edema in the extremity, breast, neck, or face ipsilateral to a permanent hemodialysis access and increase morbidity and mortality in these patients (1–4). Key risk factors for CVS are previous central venous catheter placement and transvenous rhythm devices (2–6). CVS can be located in any of the major intrathoracic (subclavian vein, brachiocephalic vein, and superior vena cava [SVC]) or intra-abdominal (iliac veins and inferior vena cava [IVC]) veins draining the extremities, where permanent hemodialysis accesses are usually placed. Symptomatic CVS is primarily treated with percutaneous transluminal angioplasty (PTA) (2,3,6–10).

Success of PTA in the peripheral vasculature can be assessed by comparing access blood flow measurements before and after PTA (11–13). In fact, the National Kidney Foundation's Kidney Dialysis Outcomes Quality Initiative (KDOQI) Guidelines state that "measurement of access flow also was shown to be a valuable tool in determining the success of a therapeutic intervention. Failure to increase access flow by at least 20% after an intervention reflects failure of the intervention to correct the underlying problem" (14). Despite this recommendation, the relationship between CVS and blood flow remains poorly understood. Although flow obstruction is the main contributor to CVS symptomatology, and PTA is the preferred treatment for symptomatic CVS, it is unclear how PTA of CVS ipsilateral to a hemodialysis access actually affects access blood flow. The present prospective study sought to quantify the change in access blood flow by using direct measurement of flow immediately before and after central venous PTA in patients undergoing hemodialysis with symptomatic CVS.

MATERIALS AND METHODS

Institutional review board approval was received for this Health Care Portability and Accountability Act–compliant prospective study. All patients presenting with symptoms indicative of CVS and having consented to fistulography and possible angioplasty or stent placement as part of their standard medical care were screened for eligibility for the study. Informed consent was obtained. Inclusion criteria were age 18–90 years, treatment with hemodialysis for chronic kidney disease, and symptomatic CVS treatable with PTA and/or stent. CVS symptoms included unilateral edema of the extremity, neck, breast, or face ipsilateral to the hemodialysis access or bilateral involvement in the event of SVC stenosis. CVS was treated only if the patient presented with one of these symptoms. Exclusion criteria included history of central venous disease independent of hemodialysis vascular access (eg, malignant stenosis), thrombosed hemodialysis access (because CVS symptoms may temporarily resolve while there is no flow in the access), CVS not amenable to PTA and/or stent placement, and previous enrollment in the study.

Between December 2012 and May 2014, 73 patients were screened, 43 refused to participate, 30 gave written informed consent and were enrolled, and five were deregistered for various reasons: one for no CVS seen on diagnostic fistulogram, one for untreatable CVS, two for treatment of non–central venous lesion between initial and final flow measurements, and one for inability to obtain a final flow measurement. Thus, 25 subjects successfully completed the study (**Table 1**). There were 15 men and 10 women. Their mean age was 62 years (range, 33–87 y). There were seven autogenous fistulae, 15 prosthetic grafts, and three hybrid hemodialysis accesses (combination of fistula and graft). Three accesses were in the forearm, 20 in the upper arm, and two in the thigh. Mean access age at time of intervention was 675 days (range, 16–3,039 d). Mean duration of CVS symptoms was 37 days (range, 3–120 d). CVS symptoms included arm (n = 20), face (n = 2), leg (n = 2), and breast (n = 1) swelling.

All procedures were performed by one of eight board-certified and/or Certificate of Added Qualifications–certified interventional radiology attending physicians or by an interventional radiology fellow under the direct supervision of an attending physician. Procedures were performed in dedicated interventional radiology suites with fixed equipment (AXIOM Artis dTA, Multistar TOP, Angiostar; Siemens, Erlangen, Germany) on an outpatient basis under moderate intravenous sedation with midazolam and fentanyl titrated to effect. For each

Table 1. Subject Selection and Demographics

Characteristic/Finding	No. of Subjects
Screened	73
Refused to participate	43
Enrolled	30
Deregistered	5
No CVS seen on diagnostic fistulogram	1
Untreatable CVS	1
Treatment of non–central venous lesion between initial and final flow measurements	2
Inability to obtain a final flow measurement	1
Completed study	25
Male	15
Female	10
Fistula	7
Graft	15
Hybrid access	3
Forearm	3
Upper arm	20
Thigh	2

CVS = central venous stenosis.