Hemodialysis graft-induced intracranial hypertension

Devin D. Mackay, MD
Valérie Biousse, MD

Practical Implications

Peripheral hemodialysis grafts may precipitate intracranial hypertension, particularly in patients with central venous stenosis, and should prompt consideration of central venous imaging. Patients may be treated by graft ligation, venoplasty ± stent placement, or CSF diversion.

Intracranial hypertension is rarely associated with peripheral hemodialysis shunts, presumably in association with central venous stenosis.[1,2] Hemodialysis Reliable Outflow (HeRO) grafts (CryoLife, Inc., Kennesaw, GA) are designed to bypass preexisting central venous stenosis by connecting the brachial artery with the venous circulation through the ipsilateral internal jugular vein (IJV) (figure, C and D).[3] We report a case of intracranial hypertension immediately after placement of a HeRO graft, review similar cases in the medical literature, and discuss possible pathophysiology.

Case report

A 60-year-old woman with a nonfunctioning right arm hemodialysis arteriovenous (AV) shunt developed blurred vision, headaches, and optic disc edema 3 days after placement of a left HeRO graft. She had a history of proliferative diabetic retinopathy treated with laser and surgery with a poor visual outcome in the left eye and relatively good vision (20/50) in the right eye. She had a history of stent placement in the proximal right subclavian vein for central venous stenosis.

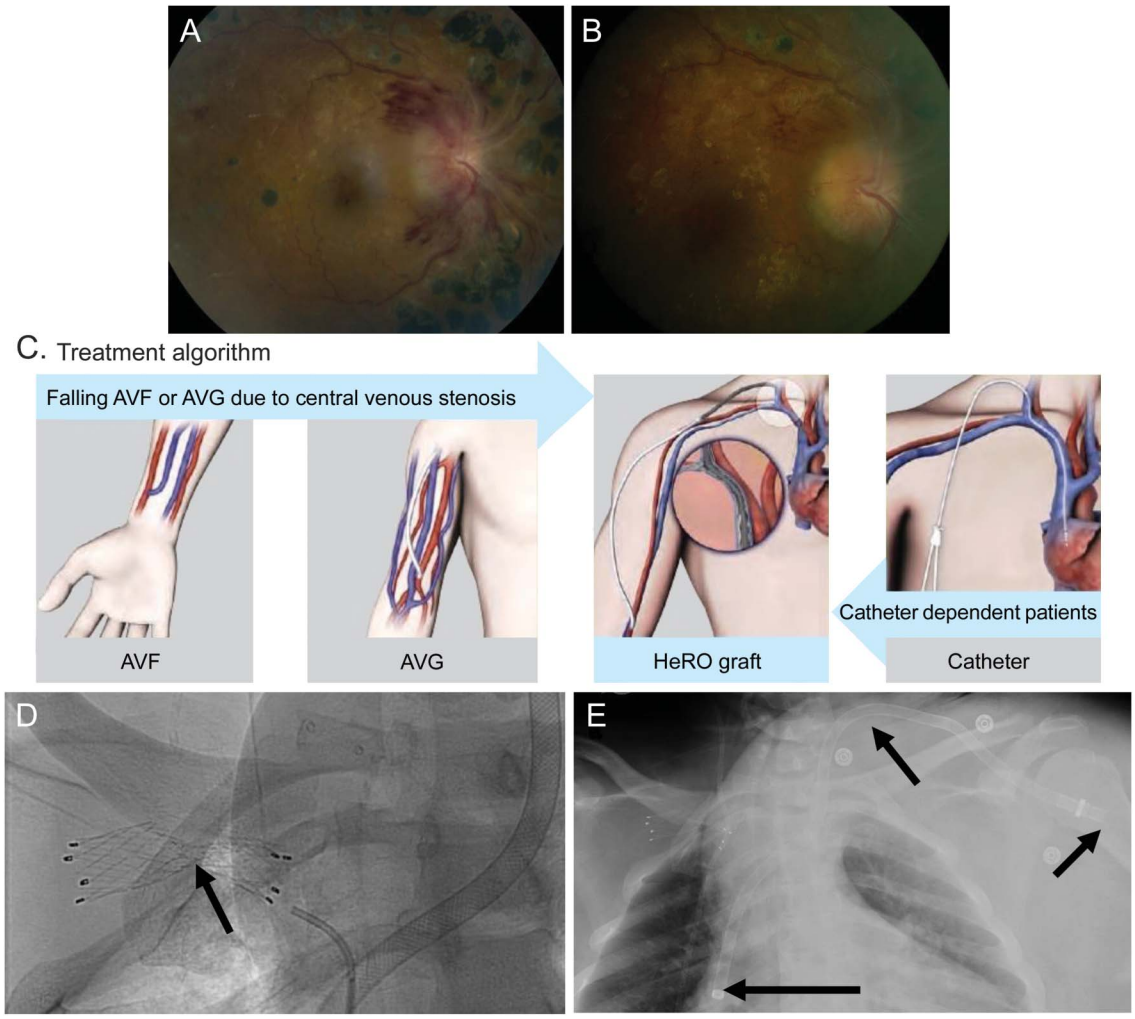
At presentation, body mass index was 43.5 kg/m^2 and blood pressure was 178/80 mm Hg. Blood urea nitrogen was 20 mg/dL. Visual acuity was unchanged from baseline: 20/50 in the right eye and count fingers at 1 foot in the left eye. Color vision was 5/14 color plates correct in the right eye, decreased from her baseline. There was a left relative afferent pupillary defect related to her previous failed left eye surgeries. Extraocular movements were full. There was severe optic disc edema with peripapillary hemorrhages, suggesting papilledema from raised intracranial pressure in the right eye (figure, A). The left ocular fundus could not be visualized secondary to previous surgeries. There was severe constriction of the right eye visual field on Goldmann visual field testing, consistent with severe papilledema. MRI and magnetic resonance venography of the head and neck demonstrated right optic disc elevation, a partially empty sella, dilated optic nerve sheaths, and bilateral distal transverse sinus stenosis without venous sinus thrombosis, suggesting intracranial hypertension. A lumbar puncture in the prone position under fluoroscopy demonstrated an opening pressure of 38 cm of water with normal CSF contents. We suspected increased central venous pressure, presumably from superior vena cava syndrome related to impaired venous return in the chest. Venography was attempted, but the guide wire could not be passed into either IJV. A right subclavian vein stent with 60%–70% midstent stenosis was found overlying the ostium

Departments of Neurology, Ophthalmology, and Neurosurgery (DDM), Indiana University School of Medicine, Indiana University Neuroscience Center, Indianapolis, IN; and Departments of Ophthalmology and Neurology (VB), Emory University School of Medicine, Atlanta, GA.

Funding information and disclosures are provided at the end of the article. Full disclosure form information provided by the authors is available with the **full text of this article at Neurology.org/cp**.

Correspondence to: vbiouss@emory.edu

Figure **Increased venous flow with central venous stenosis may be associated with intracranial hypertension**



(A) View of the right ocular fundus demonstrating optic disc edema with peripapillary hemorrhages. Dark scars from panretinal photocoagulation are visible in the periphery of the retina. (B) Improved papilledema and peripapillary hemorrhages 4 weeks after a CSF shunting procedure. (C) Suggested treatment algorithm for patients with failing arteriovenous grafts (AVGs) or arteriovenous fistulas (AVFs) due to central venous stenosis, with the Hemodialysis Reliable Outflow (HeRO) AVG demonstrating the bypassing of central venous stenosis to access the venous circulation at the internal jugular vein (IJV) (used with the permission of CryoLife, Inc.). (D) Radiograph of right subclavian vein stent stenosis overlying the ostium of the right IJV. Arrow indicates right subclavian vein stent stenosis. (E) Radiograph of the chest showing the path of the HeRO AVG from arterial anastamosis in the left brachial artery to the point of venous access at the left IJV and extension to the superior cavoatrial junction. The top arrow indicates where graft enters left IJV, right arrow indicates HeRO graft arterial access site, and left arrow indicates termination of graft with central venous access.

of the right IJV (figure, D). A CT venogram of the chest confirmed focal stenosis of a right subclavian vein stent overlying the ostium of the right IJV and a patent left-sided HeRO graft. A vascular surgery consultant recommended against HeRO graft removal. A ventriculoperitoneal shunt was placed (opening pressure 46 cm of water), and 4 weeks after surgery, her visual function was improved in the right eye with dramatic improvement of the right optic disc edema (figure, B).

DISCUSSION

A review of the English literature yielded at least 12 cases of presumed intracranial hypertension from central venous stenosis and hemodialysis AV shunts, none involving a HeRO graft (table). All cases involved brachiocephalic vein stenosis or occlusion (10 of 12) or IJV occlusion (2 of 12). All were treated with shunt ligation with or without venoplasty and

Table Literature review of intracranial hypertension from central venous stenosis and hemodialysis shunt

Reference	AV shunt type	Central venous disease	Treatment	Outcome
2	R arm AVF	R BCV thrombosis	AVF ligation	Resolution of IH
2	R arm Gor-tex AV graft	Bilateral BCV thrombosis	Graft ligation	Partial resolution of IH
4	L arm AVF	L BCV stenosis	AVF ligation	Resolution of IH
2	L arm AVF	L BCV stenosis	Venoplasty of L BCV	Resolution of IH
5	L arm AVF	L BCV stenosis	L AVF ligation, R AVF placed	Resolution of IH
2	R brachial artery to IJV graft	R axillary, SCV, BCV, and IJV occlusion	Unilateral optic nerve sheath fenestration, then graft occlusion	Resolution of IH
2	L brachiobasilic AVF	L SCV and bilateral BCV occlusion, calcified R SCV stent, SVC stenosis	Venoplasty of SVC, followed by LP shunt, followed by AVF ligation	Superior sagittal sinus thrombosis, brain infarction, and death
6	L arm AVF	L BCV occlusion	Failed L BCV recannulation, AVF ligation	Resolution of IH
6	AVF	L BCV stenosis	Venoplasty + stent in L BCV	Resolution of IH, recurrence 7 mo later, resolved with repeat venoplasty
7	R arm AV graft	R BCV occlusion	AV graft repair	Resolution of IH
2	Chronic R IJV catheter, history of failed L arm AVF	R SCV and BCV stenosis	R BCV venoplasty, removal of right IJV catheter	Resolution of IH
8	L arm AVF	L BCV occlusion	L BCV venoplasty and stent	Resolution of IH

Abbreviations: AV = arteriovenous; AVF = arteriovenous fistula; BCV = brachiocephalic vein; IH = intracranial hypertension; IJV = internal jugular vein; LP = lumboperitoneal; SCV = subclavian vein; SVC = superior vena cava.

1 of 12 was additionally treated with a lumboperitoneal shunt, with resolution of intracranial hypertension in 11 of 12 cases (complete resolution in 10 and partial in 1). One case progressed to superior sagittal sinus thrombosis, cerebral infarction, and death.[2]

Intracranial hypertension is a rare complication of hemodialysis graft placement, and a recently proposed "2 hit" hypothesis suggests that both high venous flow and venous obstruction are required risk factors, which presumably overwhelm intracranial venous outflow channels leading to elevated intracranial venous pressure, increased resistance to CSF drainage, and intracranial hypertension.[1,2] The incidence of unsuspected central venous stenosis in patients with functioning AV hemodialysis grafts is approximately 29%, but surprisingly only a small number of cases of intracranial hypertension associated with central venous stenosis and an AV hemodialysis shunt have been described.[2,5–8] Furthermore, intracranial hypertension has not been reported in association with HeRO grafts, despite increasing venous flow specifically in patients with central venous stenosis, suggesting the contribution of additional factors to the pathogenesis of hemodialysis graft-induced intracranial hypertension. Although usually treated by graft ligation or venoplasty with or without a stent, CSF shunting without graft ligation is also a treatment option in patients with isolated intracranial hypertension whose venous anatomy is seriously compromised. Venous imaging of chest/neck veins in hemodialysis patients with unexplained intracranial hypertension may expedite diagnosis and appropriate treatment and should be considered in cases with previous AV shunts.

REFERENCES

1. Taban M, Taban M, Lee MS, Smith SD, Heyka R, Kosmorsky GS. Prevalence of optic nerve edema in patients on peripheral hemodialysis. Ophthalmology 2007;114:1580–1583.

2. Simon MA, Duffis EJ, Curi MA, Turbin RE, Prestigiacomo CJ, Frohman LP. Papilledema due to a permanent catheter for renal dialysis and an arteriovenous fistula: a "two hit" hypothesis. J Neuroophthalmol 2014;34:29–33.
3. Katzman HE, McLafferty RB, Ross JR, Glickman MH, Peden EK, Lawson JH. Initial experience and outcome of a new hemodialysis access device for catheter-dependent patients. J Vasc Surg 2009;50: 600–607.
4. Hartmann A, Mast H, Stapf C, Koch HC, Marx P. Peripheral hemodialysis shunt with intracranial venous congestion. Stroke 2001;32:2945–2946.
5. Nishimoto H, Ogasawara K, Miura K, Ohmama S, Kashimura H, Ogawa A. Acute intracranial hypertension due to occlusion of the brachiocephalic vein in a patient undergoing hemodialysis. Cerebrovasc Dis 2005;20:207–208.
6. Herzig DW, Stemer AB, Bell RS, Liu AH, Armonda RA, Bank WO. Neurological sequelae from brachiocephalic vein stenosis. J Neurosurg 2013;118:1058–1062.
7. Samaniego EA, Abrams KJ, Dabus G, Starr R, Linfante I. Severe venous congestive encephalopathy secondary to a dialysis arteriovenous graft. J Neurointerv Surg 2013;5:e37.
8. Prasad V, Baghai S, Gandhi D, Moeslein F, Jindal G. Cerebral infarction due to Central vein occlusion in a hemodialysis patient. J Neuroimaging doi: 10.1111/jon.12152. Epub 2014 Jul 23.

ACKNOWLEDGMENT

Financial support was provided in part by an unrestricted departmental grant (Department of Ophthalmology, Emory University) from Research to Prevent Blindness, Inc., New York, and by the NIH/NEI core grant P30-EY06360 (Department of Ophthalmology, Emory University).

STUDY FUNDING

No targeted funding reported.

DISCLOSURES

D.D. Mackay reports no disclosures. V. Biousse serves on the editorial boards of *American Journal of Ophthalmology* and *Journal of Neuro-ophthalmology*; is a consultant for GenSight (Paris, France); receives publishing royalties for *Walsh and Hoyt's Clinical Neuro-Ophthalmology* (Lippincott Williams & Wilkins, 2007), *Neuro-Ophthalmology Illustrated* (Thieme, 2009), and *Up-to-Date*; and receives research support from Research to Prevent Blindness. Full disclosure form information provided by the authors is available with the **full text of this article at Neurology.org/cp**.