Successful Percutaneous Recanalization of a Chronically Occluded Inferior Vena Cava in a Young Child

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Abstract

Young children with congenital heart disease are undergoing an increasing number of catheter-based interventions. These procedures can lead to obstruction of large central veins, making future interventions more challenging or even impossible. We present a young child with a chronically occluded inferior vena cava (IVC) secondary to prior catheterization-based interventions for congenital heart disease. The IVC was recanalized with serial angioplasty and stent placement with continued patency for over 2 years. Despite the long duration of obstruction, the IVC was successfully recanalized, eliminating the potential consequences of long-term IVC obstruction and making it easier for future catheter-based interventions, if needed.

Introduction

Venous obstruction has long been an issue, particularly for patients with indwelling central venous catheters, which are prone to thrombus formation and vessel occlusion. Children with congenital heart disease (CHD) have the additional risks of cardiac catheterizations and major surgical interventions at early ages that can also contribute to the occlusion of major central veins,[1] making future interventions more challenging or even impossible. Reported complications of central venous occlusion include venous stasis, extensive collateralization with potential compression of surrounding structures, varicosity, claudication, renal vein thrombosis and Budd-Chiari syndrome if there is hepatic vein involvement[1,2]. Children are likely at higher risk for these complications because of the longer duration of venous obstruction during their lifetime.

Endovascular treatments, including angioplasty and stent placement, have been reported for many years for older patients, most frequently for upper extremity venous obstruction[3-5]. There are small series reporting treatment of venous obstruction in children, mostly with CHD after surgery or catheterizations, with reasonable intermediate success[1, 6-8]. Early methods of recanalization were somewhat coarse, frequently relying on transseptal needles and were mostly for fairly acute obstructions. The ability to recanalize occluded central veins, particularly those that are chronically occluded, can be extremely important in optimizing the care of this patient population.

We present a case of a child with a long-segment obstruction of her inferior vena cava (IVC) for nearly 3 years that was successfully recanalized by a percutaneous approach.

Patients and Methods

The patient is a 5 year-old girl with Scimitar syndrome [partial anomalous pulmonary venous return of the right middle and lower veins to the inferior vena cava (IVC), arterial collaterals off the descending aorta to a sequestered right lower lung lobe]. While under care at a different institution, she developed severe, symptomatic pulmonary overcirculation by 6 weeks of age and underwent her first catheterization to embolize the arterial collaterals. The family was not interested in surgical correction, so the decision was made at 10 months to perform percutaneous atrial septal defect (ASD) and patent ductus arteriosus (PDA) closure with a 6 mm Amplatzer Septal Occluder (St. Jude Medical [now Abbott], St. Paul, MN) and 5/4 Amplatzer Duct Occluder (St. Jude Medical), respectively, from a femoral venous approach using a 6-French long delivery sheath. At subsequent catheterization at 3 years old, near-complete occlusion of her intrahepatic IVC with collateralization to hepatic veins was identified, but no intervention was performed. Two and a half years later, she was admitted to our institution for the first time for hemoptysis and was found to have an abscess in the sequestered right lower lobe in close proximity to the Scimitar vein; there were no obvious symptoms from the IVC occlusion. The decision was made to remove the sequestered lobe, but in the setting of recent infection, surgical pulmonary venous intervention was deferred. There was also concern that the location of the abscess might require a complete right pneumonectomy rather than just a lobectomy. She was referred for catheterization to help carefully define the vascular anatomy, assess her hemodynamics, including shunt quantification and pulmonary resistance, as well as potential recanalization of the IVC.

The procedure was performed under general anesthesia with access in the right femoral vein and artery and right internal jugular vein. Systemic heparin was given (100 units/kg) and

redosed to maintain an ACT over 200 seconds. Hemodynamics revealed a mildly elevated pulmonary artery pressure (mean 27 mmHg), normal resistance (2.75 indexed Wood units) and a trivial left to right shunt (Qp:Qs 1.06:1). The IVC appeared completely occluded with significant collateralization through hepatic veins that entered the right atrium (RA) near the Scimitar vein (Figure 1a). A 6-French MPA guide catheter (Boston Scientific Corp, Natwick, MA) was positioned as proximal as possible in the IVC and we attempted to pass a standard 0.035" guidewire through the true IVC lumen without success. Because of the chronicity of the obstruction, we opted to use typical equipment for a coronary artery chronic total occlusion and a 0.014" Whisper wire (Abbott Vascular, Santa Clara, CA), supported by a Corsair microcatheter (Asahi Intecc USA, Inc, Santa Ana, CA), was carefully advanced with gentle pressure through the true IVC lumen to the superior vena cava (Figure 1b). The Whisper wire was snared and externalized from the jugular sheath creating a veno-venous rail for support (Figure 1c). An angled glide catheter (Terumo Medical Corp, Somerset, NJ) was advanced over the Whisper wire from the femoral vein, and a 0.035" Rosen wire (Cook Medical, Bloomington, IN) advanced through the glide catheter. This was snared and externalized and a 7-French Flexor sheath (Cook) was advanced to the IVC-RA junction (Figure 1d).

A small tract was dilated with a 6 mm x 3 cm Powerflex balloon (Cordis Corp, Miami Lakes, FL) (Figure 1e). The Flexor sheath was exchanged for a 10-French Flexor sheath to accommodate stent placement, and a series of three Palmaz XL 3110 stents (Cordis) were hand-mounted onto a 12 mm OptaPro balloon (Cordis) and deployed in telescoped fashion to cover the entire length of IVC obstruction. Because of the insertion of the anomalous pulmonary veins near the IVC-RA junction, the use of covered stents was not used. Angiography showed marked

improvement in the IVC size with diminished flow through the hepatic vein collaterals. (Figure 1f).

The procedure was safe and well-tolerated. She was discharged on aspirin and clopidogrel. A chest CT performed 4 months after the catheterization showed patency of the stents and Scimitar vein with a marked reduction in the hepatic vein collaterals (Figure 2). She underwent successful lobectomy of the sequestered lobe and the majority of the right lung remained intact. Serial echocardiography up to 2 years post-procedure has demonstrated continued patency of the IVC stents. There are future plans to redilate the IVC stents as she grows, but given the small shunt from the Scimitar vein, there are not currently plans to surgically correct this.

Discussion

While recanalization of obstructed veins has been reported[3-8], this is one of the few to address a chronically occluded large central vein in a young child with CHD. Children are probably at higher risk for the chronic effects of large central vein obstruction due to an earlier age at which obstruction occurs[1,2]. In addition, children with CHD frequently require multiple surgical and catheter-based interventions which can be much more complicated in the setting of obstructed central veins. For all of these reasons, it is important to consider procedures to recanalize obstructed veins in children, regardless of the chronicity of occlusion.

Many reports of successful recanalization include the use of transseptal needles to cross relatively acute obstructions. In our patient, we were able to use equipment typically used to treat chronic total occlusion in coronary arteries, which likely reduced the risk of severe trauma to the

vessels and surrounding structures in a smaller patient. In addition, using smaller wires and catheters may make it easier to find the true vessel lumen in near-complete occlusions.

For this patient, closed cell Palmaz XL stents were used and the Scimitar vein was jailed, but remained patent. We did not have open cell stents available at the time of the procedure, but these would also have been a good option for treatment and would have allowed for dilation of the side cells to increase patency of the Scimitar vein as well as hepatic veins that could have become jailed. Another consideration in some patients with similar anatomy would be to intentionally use covered stents to exclude the anomalous pulmonary vein if it only provides return of desaturated blood from the sequestered lung lobe. While our approach was appropriate for this patient, patients in whom surgical reimplantation of the anomalous pulmonary vein is considered might have a more complicated surgical intervention due to the presence of stents near the vessels of interest.

Conclusion

Our case highlights the importance of and ability to restore patency of obstructed central veins, even when occluded for several years. Most importantly, while central venous obstruction in pediatric patients is technically achievable, the best treatment would be to prevent the occlusion in the first place by removing central venous lines as quickly as possible and perhaps redesigning equipment for pediatric cardiac catheterizations to be less traumatic and thrombophilic.

Declaration of Conflicting Interests

The Authors declare that there is no financial support or conflicts of interest to report. The authors had full control of the design of the study, methods used, outcome parameters, analysis of data and production of the written report. Permission was granted by the parent to publish this case report.

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Figure legends

Figure 1 Angiogram of chronically occluded IVC with collateralization through hepatic veins (a). Passage of a Whisper wire in a Corsair catheter through the true IVC lumen up to the superior vena cava, snaring of the wire and advancement of a long sheath to the IVC-right atrium junction (b-d). Balloon dilation of a small tract in the intrahepatic IVC (e). Final angiography after placement of three stents in the intrahepatic IVC showing marked improvement in flow; note the decreased flow in the collateral vessels (f). Note previously placed embolization coils in arterial collaterals to the sequestered lung segment as well as the Amplatzer Septal Occluder in the atrial septal defect and the Amplatzer Duct Occluder in the patent ductus arteriosus.

Figure 2 3D reconstruction of post-catheterization chest CT demonstrating patency of the scimitar vein (*), despite jailing by the stents, and IVC stents (arrow). Color image available in the online version of the article.