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CASE REPORT

ADVANCED

CLINICAL CASE

Hybrid Transcarotid Exclusion of Postoperative Ascending Aortic Dissection in an Infant

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ABSTRACT

Aortic dissection is very rare in pediatric patients, and associated risk factors include congenital heart disease, previous cardiac surgery, and vasculopathies. Acute postoperative aortic dissection in pediatric patients can be life-threatening. We performed a novel hybrid transcarotid covered stent exclusion of a postoperative ascending aortic dissection in an infant. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2022;4:226–229) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 13-month-old (8.2-kg) infant presented with heart failure secondary to progressive subaortic and mitral stenosis. Resection of the supravalvular mitral ring, mitral valve repair, and enucleation of the subaortic obstruction resulted in significant improvement of her left-sided heart gradients. On postoperative day (POD) 3, she experienced acute hypotension and respiratory failure requiring transthoracic venoarterial extracorporeal membrane oxygenation (ECMO).

LEARNING OBJECTIVES

- To identify aortic dissection as a life-threatening complication of cardiac surgery in patients with CHD to avoid delays in diagnosis.
- To recognize limitations of noninvasive imaging in diagnosis of acute aortic dissection.
- To demonstrate that endovascular management of aortic dissection is possible in pediatric patients with the use of a creative multidisciplinary approach.

PAST MEDICAL HISTORY

This infant with Shone complex, bicuspid aortic valve, parachute mitral valve with supravalvular mitral ring, subaortic stenosis, hypoplasia of the ascending aorta (AA), and coarctation of the aorta underwent coarctation repair and patch augmentation of the AA as a neonate. At 6 months of age, she underwent balloon aortoplasty followed by patch augmentation of recurrent AA stenosis. Significant proximal coronary artery aneurysms (CAAs) developed and raised concern for a vasculopathy.

DIFFERENTIAL DIAGNOSIS

Given the known bilateral proximal CAAs and a suspicion of vasculopathy, the differential diagnosis for

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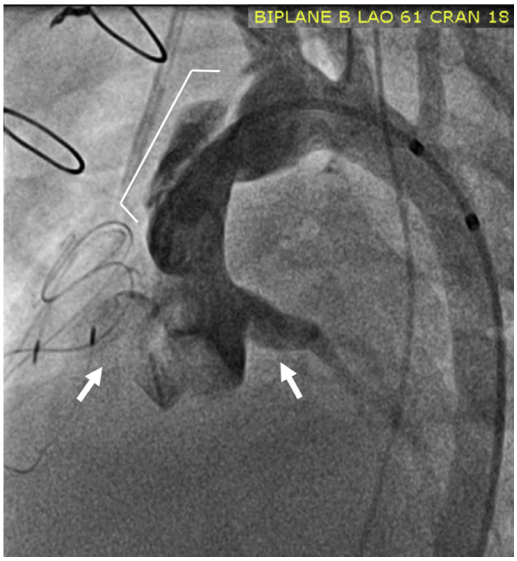
FIGURE 1 Aortic Root Angiogram



Aortic root angiogram demonstrating a large, obstructive dissection **(bracket)** extending from the midascending aorta to the base of the innominate artery. The coronary arteries are aneurysmal **(arrows)** but stable in size without obstruction. CRAN = cranial; LAO = left anterior oblique.

her acute decompensation included an acute coronary event and acute aortic dissection.

INVESTIGATIONS

Echocardiography demonstrated left ventricular (LV) dilation, without appreciable gradient across the LV outflow tract in the setting of severely reduced systolic function. After stabilization and ECMO decannulation, on POD 13 cardiac catheterization and angiography demonstrated a large AA dissection (**Figure 1**) producing a 66-mm Hg systolic gradient and LV decompensation (left ventricular end-diastolic pressure [LVEDp] ~40 mm Hg). The CAAs were stable, without evidence of obstruction.

MANAGEMENT

Given the infant's tenuous clinical state, surgical repair of the dissection was believed to carry substantial risk. On POD 15, she returned for transcatheter intervention. A right carotid artery (RCA) cutdown was performed for vascular access. A 6-0 polypropylene (Prolene, Ethicon) purse-string suture was placed on the anterior surface of the RCA, and an 8-F sheath was introduced using a modified Seldinger technique. The floppy tip of a 0.035-inch Magic Wire (Boston Scientific) was cautiously manipulated across the AA dissection and was used to deliver the sheath tip into the aortic root for angiography (**Figure 2**, Video 1). The balloon of a 7 mm × 22 mm iCAST covered stent (Atrium Medical) was partially inflated so the premounted stent could be removed (**Figure 3A**). This stent was manually crimped onto a 10 mm × 2 cm OptaPro Balloon (Cordis) (**Figures 3B and 3C**). The guidewire was manipulated into the left ventricle, and the balloon carrying the covered stent was advanced through the 8-F sheath and positioned across the area of dissection (**Figure 4A**, Video 2). The stent was implanted (**Figure 4B**) during rapid dual-chamber pacing using temporary epicardial leads. Poststent angiography revealed a patent AA and innominate artery with exclusion of the dissection (**Figure 4C**, Video 3). The AA gradient was abolished, and the LVEDp fell to 10 mm Hg. The sheath was removed, and the RCA was repaired.

ABBREVIATIONS AND ACRONYMS

AA = ascending aorta

CAA = coronary artery aneurysm

CHD = congenital heart disease

ECMO = extracorporeal membrane oxygenation

ePTFE = expanded polytetrafluoroethylene

LV = left ventricular

LVEDp = left ventricular end-diastolic pressure

POD = postoperative day

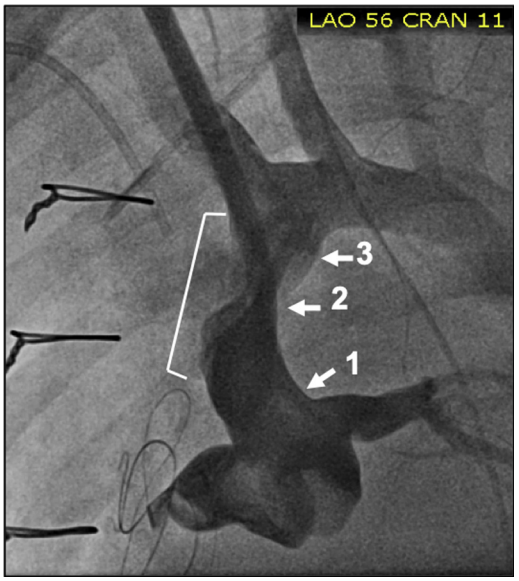
RCA = right carotid artery

DISCUSSION

Aortic dissection is a rare diagnosis in pediatric patients, with very few cases reported in those aged younger than 14 years.[1-2] This patient demonstrated many of the risk factors for development of aortic dissection, including congenital heart disease (CHD), previous cardiac surgery, and possible vasculopathy (CAA).[3-7] Perioperative aortic dissection as a complication of aortic cannulation is rarely cited in the published reports but is more common in patients with CHD.[8,9] The acuity of our patient's clinical decompensation and her substantial recovery after intervention emphasize maintaining a high index of suspicion for this diagnosis.

Because of the child's tenuous clinical status, we performed a novel hybrid approach for transcarotid covered stent exclusion of the dissection. Considering the small size of the infant, this approach allowed us to overcome several limitations of standard endovascular exclusion, including large delivery system profiles, large endograft size and length, and the absence of approved devices for this purpose. We elected off-label use of a specific balloon-expandable covered stent on the basis of its characteristics of relatively low profile, appropriate expansion lengths and diameters, and the expanded polytetrafluoroethylene (ePTFE) covering extending the entire length of the stent. Besides length, all of these particular stents are manufactured to exactly the same specifications regardless of which diameter

FIGURE 2 Aortogram After RCA Cutdown



Angiogram through the right carotid artery (RCA) sheath with the tip in the aortic root showing severe aortic obstruction from the dissection. The proximal ascending aorta **(arrow 1)** is 8.8 mm, the minimal diameter **(arrow 2)** is 3.6 mm, the distal ascending aorta **(arrow 3)** is 9.9 mm, and the length of dissection **(bracket)** is 18.8 mm. Abbreviations as in Figure 1.

balloon they are mounted onto. These premounted stents are attached to balloons with diameters of 5 to 10 mm; however, the largest balloon carrying the 22-mm length stent is 7 mm in diameter. On the basis of the aortic dimensions proximal and distal to the lesion (Figure 2), the stent needed to be expanded at implantation to 10 mm in diameter for stable position. Achieving the appropriate stent diameter for this aortic implant required removal of the 22-mm length stent from its delivery balloon and remounting on a larger-diameter balloon. Care is required not to injure the ePTFE and not to overexpand the stent during removal so it can be manually crimped with the lowest profile on the new balloon. Because the ePTFE covers both external and internal aspects of the stent, diligence is required on delivery of the stent through the sheath to ensure that it does not shift position on the balloon.

We elected RCA access, given that the endovascular approach across the dissection is opposite the entrance of the lesion. This approach allowed better control of stent position during implantation to avoid stent mobilization or embolization. Alternatively, hybrid LV transapical access could be used[10]; however, it is more invasive, requires manipulation of injured LV myocardium, and requires crossing the dissection from the entrance side of the lesion.

The existing reports of treatment of aortic dissection in pediatric patients focus on immediate surgical intervention.[3,8] To our knowledge this is the first reported hybrid transcatheter approach used in a pediatric patient with aortic dissection.

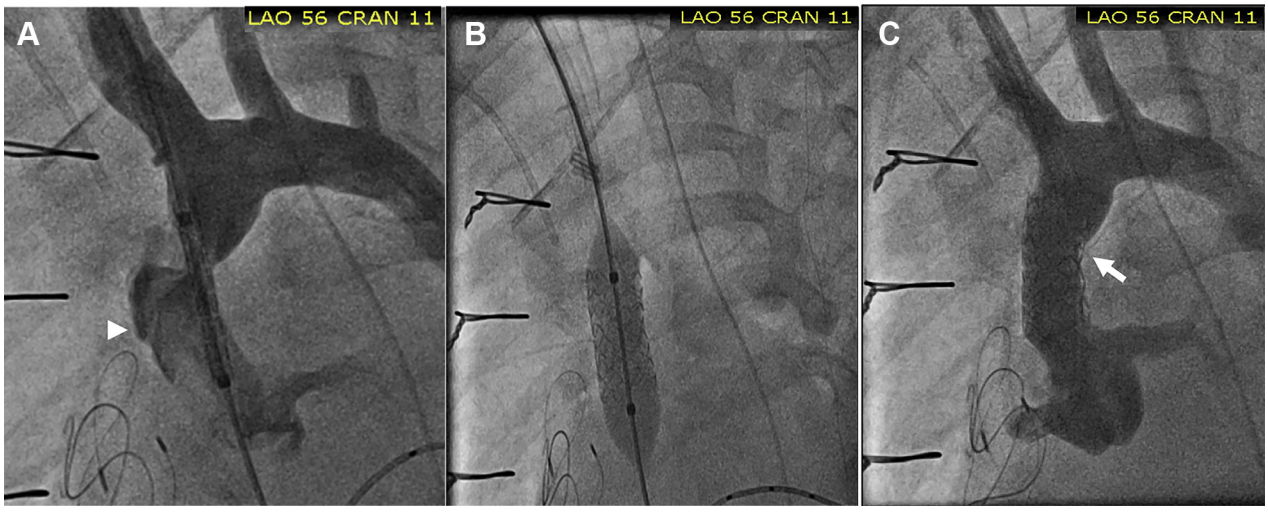
FOLLOW-UP

The patient's clinical status improved, and she was transitioning to the rehabilitation phase of her care. Although she demonstrated significant improvement, she had persistent heart failure necessitating LV assist device placement 31 days after the procedure. Aortic cannulation was required, so the AA (with stent) was resected with subsequent placement of an interposition graft. The aorta remained patent, and the dissection was well contained. She underwent successful orthotopic heart transplantation with removal of the interposition graft and replacement with the donor aorta. Microscopic examination of

FIGURE 3 Stent Preparation

(A) The covered stent after partial expansion with the premounted balloon. **(B)** The covered stent positioned on the 10-mm balloon used for delivery. **(C)** The final prepared stent after manual crimping to the minimal profile.

FIGURE 4 **Covered Stent Implantation**



(A) Covered stent positioned across the dissection angiographically (**arrowhead,** entrance to dissection). **(B)** Balloon expansion to implant the stent. **(C)** Final aortic root angiogram demonstrating patency of the aortic lumen and exclusion of the dissection. Minimal diameter **(arrow)** is 8.0 mm. Abbreviations as in Figure 1.

ascending aortic tissue showed standard postoperative and dissection healing changes and no distinct aortopathy.

CONCLUSIONS

Aortic dissection is a rare diagnosis in pediatric patients, but patients with CHD and history of cardiac surgery are at risk of this life-threatening complication. Hybrid transcarotid covered stent placement is an alternative to surgical intervention in selected patients with acute aortic dissection.

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KEY WORDS **aortic dissection, congenital heart disease, covered stent, hybrid, iCAST stent, infant**

APPENDIX **For supplemental videos, please see the online version of this paper.**