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CASE REPORT: CLINICAL CASE SERIES

Endovascular Repair of Thoracic Aortic Pseudoaneurysms in Children

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ABSTRACT

Pediatric aortic pseudoaneurysms are rare and can result in life-threatening sequelae. We describe 2 cases of exclusion of descending thoracic aortic pseudoaneurysm by different approaches, chosen based on the anatomy and cause of the lesions. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2020;2:1895–8) © 2020 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/).

CASE 1

A new-born male received a diagnosis of tetralogy of Fallot, pulmonary atresia, hypoplastic pulmonary arteries, and aortopulmonary collaterals (MAPCAs). During hospitalization he was treated for a methicillin-resistant *Staphylococcus* bacteremia related to an indwelling arterial umbilical catheter. Ultimately, he underwent 4-mm aortopulmonary shunt placement.

At 8 months of age, cardiac catheterization was performed for surgical staging. Vitals were heart rate of 115 beats/min, blood pressure of 106/52 mm Hg, and oxygen saturation (Sa_{O_2}) of 85%. Examination revealed a normal S1, a single S2, and a grade-3 continuous murmur. Aortic angiography demonstrated a saccular pseudoaneurysm of the descending thoracic aorta at thoracic levels T8 to T9 (**Figure 1**, Video 1). It measured 10 mm in length and 14 mm in diameter and with a 6-mm neck. This pseudoaneurysm was presumed to be mycotic, given the prior umbilical artery catheter infection. A decision was made to exclude the aneurysm by an endovascular approach prior to surgical repair of tetralogy of Fallot to lessen the complexity and duration of surgery. Shortly thereafter, the patient was returned to the catheterization laboratory, weighing 7.8 kg. Arterial access was obtained, and a descending aortic angiogram was performed. Endovascular stenting was precluded in this patient based on his size. An Azur Framing coil, 0.035-inch, 14 mm × 34 cm (Terumo, Somerset, New Jersey) was deployed in the pseudoaneurysm lumen. This was followed by deployment of 2 Azur detachable hydrocoils (0.035-inch, 12 mm × 20 cm; and 0.035-inch 8 mm × 15 cm) to fill the lumen of the saccular pseudoaneurysm. An aortogram confirmed complete exclusion. Dual-supply MAPCAs were embolized during this procedure. Total procedural and fluoroscopy times were 60 min and 13 min,

LEARNING OBJECTIVES

- A minimally invasive endovascular approach may be considered for repair of thoracic descending aortic pseudoaneurysms in children with higher surgical risk.
- Strategies should be chosen based on associated risks and benefits of various approaches and specific anatomy and cause.

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ABBREVIATIONS AND ACRONYMS

CT = computed tomography

LFA = left femoral artery

MAPCAs = multiple aortopulmonary collaterals

Sao_2 = arterial oxygen saturation

VSD = ventricular septal defect

respectively. There were no periprocedural complications. Surgical right ventricle-pulmonary artery conduit placement, VSD closure, and pulmonary arterioplasty were performed the following day. A computed tomography (CT) angiogram obtained 1 week later and cardiac catheterization at 17 months of age confirmed exclusion of the pseudoaneurysm (**Figure 2**, Video 2).

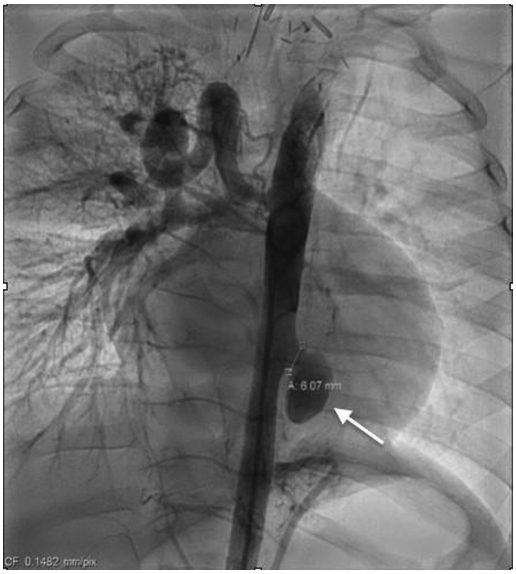
CASE 2

A 3-year-old, 15-kg male presented to an outside hospital after a high-speed motor vehicle accident. Cardiac contusion based on elevated troponin concentrations (47 ng/dl) and a flail anterior tricuspid valve leaflet with severe regurgitation on echocardiography were diagnosed. The patient developed hypotension requiring fluid resuscitation. Chest CT revealed a saccular descending aortic pseudoaneurysm measuring 5 × 5 mm at the thoracic T7 to T8 level (**Figure 3**). Vital signs at the time of transfer were heart rate of 144 beats/min, a blood pressure of 90/53 mm Hg, and an oxygen saturation (Sao_2) of 100%. On examination, a normal S1, S2, and grade 3 pansystolic murmur were auscultated along the left sternal border. Due to the severe tricuspid regurgitation and evolving clinical decompensation, the decision was made to surgically repair the tricuspid valve after exclusion of the aneurysm. Endovascular repair of the pseudoaneurysm was chosen to obviate the need for 2 surgical entry sites, to mitigate the risk of rupture with cannulation, and to limit cardiopulmonary bypass time.

In the catheterization laboratory, a 4-F sheath was placed in the left femoral artery (LFA). Aortic angiography showed the saccular pseudoaneurysm measured 5 × 5 mm with maximal aortic diameter at the level measuring 8.5 mm (Video 3). The aortic diameters proximal and distal to the pseudoaneurysm were 8.3 mm and 8 mm, respectively.

The LFA was serially dilated after measurements of LFA, and the iliac artery was believed to be of adequate size. A 12-F Flexor (Cook Medical, Bloomington, Indiana) long arterial sheath was introduced. A 2.2-cm covered Cheatham-Platinum stent (NuMed, Hopkinton, New York) was mounted on a 10-mm × 2.5-cm Balloon-in-Balloon catheter (NuMed, Hopkinton, New York). The covered stent was deployed after confirming the position angiographically. Final angiograms demonstrated an aortic luminal diameter of 10 mm with complete exclusion of the pseudoaneurysm (**Figure 4**, Video 4). Procedural and fluoroscopy times were 26 min and 5.2 min, respectively.

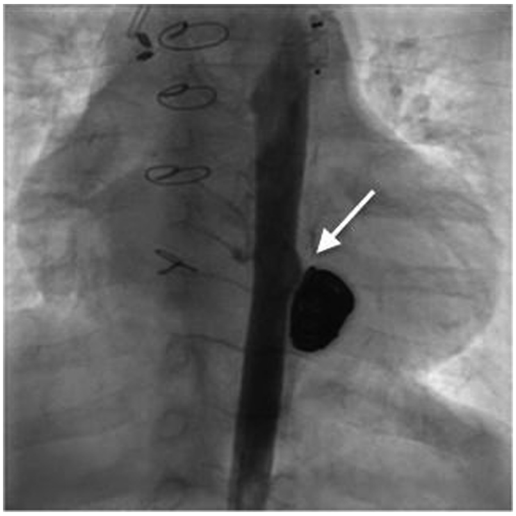
FIGURE 1 **Mycotic Pseudoaneurysm**



Angiogram of the descending thoracic aorta demonstrates a saccular pseudoaneurysm **(arrow)**. The neck measures 6.1 mm. Multiple aortopulmonary collaterals are also seen originating from the descending aorta.

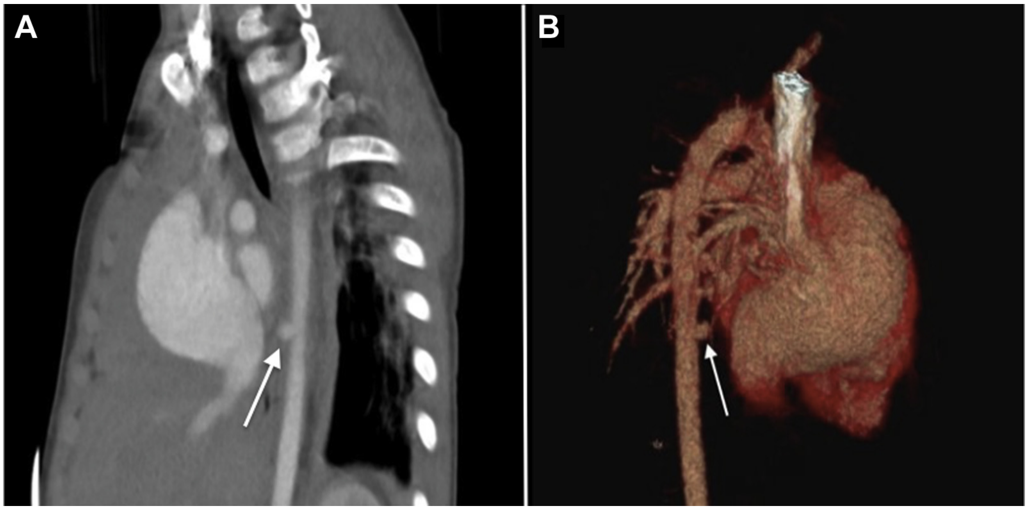
Immediately following this, the patient underwent surgical tricuspid valve replacement using a 19-mm mechanical valve (St. Jude, Minneapolis, Minnesota) after an unsuccessful attempt at tricuspid valve

FIGURE 2 **Post-Coil Embolization**



Descending thoracic aortogram obtained 9 months after coil embolization shows complete exclusion of the pseudoaneurysm.

FIGURE 3 **Computed Tomography Angiogram of the Heart**



(A) Sagittal oblique view reveals a traumatic pseudoaneurysm in the descending thoracic aorta **(arrow)** above the level of the diaphragm. **(B)** A 3D reconstruction demonstrates the pseudoaneurysm **(arrow)** from the descending thoracic aorta in this posterior view.

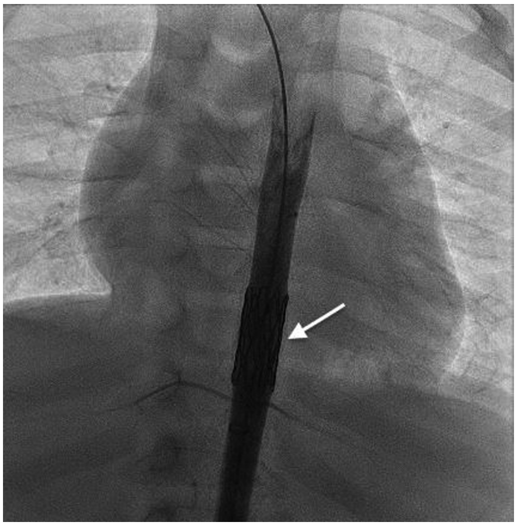
repair. The postoperative recovery was uneventful. The patient was discharged on warfarin and aspirin prophylaxis. He has had frequent follow-up examinations and admissions since surgery for warfarin management and noncompliance. At his most recent follow-up, 10 months after the procedure, the stent appeared intact with no evidence of turbulence or narrowing on transthoracic echocardiography. A CT angiogram will be performed within 1 year after the procedure to ensure there is no recurrence of the aneurysm.

DISCUSSION

Aortic pseudoaneurysms are rarely seen in children. Many are asymptomatic and are discovered incidentally (1). A pseudoaneurysm is a localized dilation of the vessel that occurs due to transmural disruption of the arterial wall. Important causes include infection, trauma, and previous cardiovascular surgery, or they may be iatrogenic. They can result in thromboembolism or fatal rupture when untreated. Open surgery has been the gold standard for repair (1-3). The advent of endovascular repair has altered the management of these lesions in adults and has been used in a small number of children (3,4).

This paper presents 2 children whose endovascular treatment approaches were chosen based on the causes and anatomy of the lesions. In the first patient, a detachable hydrocoil (Terumo) embolization technique was chosen for exclusion of the pseudoaneurysm due to the presence of a narrow neck, minimizing migration risk, and the aneurysm's longstanding presence, making the risk of rupture less

FIGURE 4 **Covered Stent Placement**



Descending aortogram obtained after covered Cheatham-Platinum stent placement **(arrow)** reveals complete exclusion of the pseudoaneurysm with no endoleaks or aortic wall injury.

likely. Coil exclusion of an aneurysm, if successful, can be curative as opposed to covered stent placement that may need reintervention.

A hydrocoil consists of a Platinum coil with an expandable hydrogel polymer that expands when in contact with blood. There is limited expansion in the first 3 min, providing the operator a window for repositioning or retrieval. Maximum expansion occurs in 20 min. The coil expands to 3 to 4 times its original diameter, decreasing the number of coils required. Most of the aneurysm is filled by expansion of the hydrocoil, promoting organized thrombus. Histologic specimens of aneurysms embolized with hydrocoils in animal models revealed the aneurysm filled by coils, hydrogel, neointima, and minimal thrombus. Consequently, the incidence of recanalization due to thrombolysis and aneurysm regrowth is low. This technique is preferable in small children as the 0.018-inch coils can be deployed using a microcatheter. Embolization can be safely performed when there is a risk for adjacent aortic branch occlusion, as with covered stents. The need for reintervention is less likely in comparison to that with covered stent placement, given the need for redilation with somatic growth. Complications of hydrocoil embolization include recurrence of the aneurysm due to incomplete packing and coil migration (5,6).

In the second patient, given the uncertainty of aneurysmal wall integrity following the trauma and the wide neck of the aneurysm, covered stent placement was preferred over coil embolization. Covered Cheatham Platinum stents (NuMed) used for endovascular repair of recurrent coarctation of aorta have been used in pediatric patients >20 kg for exclusion of aortic aneurysms. These balloon-expandable stents were chosen due to comparatively smaller sheaths required for deployment of the stent and the ability to redilate the stent later if needed (4). Balloon-expandable stents can be mounted on balloons of various diameters, which facilitates placing the stent in vessels with a wide range of diameters. The present patient received a 2.2-cm stent dilated to 10 mm that could be expanded up to 24 mm in diameter. Based on available studies, this patient might have been the youngest patient in whom a balloon-expandable covered stent was deployed for exclusion of post-traumatic aortic pseudoaneurysm (4). Adverse events associated with this procedure include endoleaks, stent migration, stent fracture, vascular injury, atheroembolism, and distal lower limb ischemia (4,7).

CONCLUSIONS

An endovascular approach for exclusion of thoracic descending aortic pseudoaneurysm is less invasive. It may be an option in relatively young children with favorable anatomy who are deemed to have a higher surgical risk.

AUTHOR RELATIONSHIP WITH INDUSTRY

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS covered stent, hydrocoil embolization, traumatic pseudoaneurysm

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