

# Hybrid retrieval of embolized device in abdominal aorta after transcatheter closure of large patent ductus arteriosus

Mosaad Soliman, PhD, Khaled Mowaphy, PhD, Nshaat A. Elsaadany, MD, and Reem Soliman, MD, Mansoura, Egypt

## ABSTRACT

Patients with a large patent ductus arteriosus (PDA) can have several presentations. Many will be asymptomatic, some could develop severe pulmonary hypertension, and others can develop Eisenmenger syndrome. We have presented a case in which a PDA correction device was embolized to the abdominal aorta, 2 months after transcatheter closure of a large PDA. The patient presented with an acute abdomen. In the management of the case, we implemented a hybrid technique in the process of device retrieval. Transbrachial access and a lower abdominal midline incision were accomplished to dislodge the device from the supraceliac aorta to the aortic bifurcation. The Amplatzer Ductal Occluder (St Jude Medical Inc, St Paul, Minn) was extracted through a small arteriotomy of the distal abdominal aorta. The procedure was followed by a dramatic improvement of the ischemic liver and bowel, evidenced by the vanishing of the cyanotic hue of the liver and normalization of the bluish discoloration of the intestine. (*J Vasc Surg Cases and Innovative Techniques* 2021;7:56-60.)

**Keywords:** Device embolization; Large PDA; Transcatheter closure

Cardiac defects are the most common birth defects, constituting nearly one third of all major congenital anomalies.<sup>1</sup> The incidence of congenital heart disease varies widely worldwide. Although usually reported at eight cases per 1000 live births, this estimate has been considered inaccurate without regional variations included.<sup>2</sup> The underlying lesions range from a simple septal defect to more complex structural abnormalities. Most of those born with cardiac defects will lead active lives and survive well into late adulthood.<sup>3</sup> Although ventricular septal defects are the most common defects, atrial septal defects (ASDs) and patent ductus arteriosus (PDA) are also relatively common. In contrast, anomalous pulmonary venous connections, either total or partial anomalous pulmonary venous connection (PAPVC), are rare defects. A total anomalous pulmonary venous connection refers to all four pulmonary veins draining at the anomalous site. In contrast, a PAPVC refers to a subgroup of veins inserting at the anomalous site and the remaining veins inserting into the left atrium.<sup>4</sup>

The optimal management of PDA has continued to be debated, with drug therapy, surgical ligation, and

catheter-based closure the available therapies. The data supporting transcatheter closure (TCC) of a PDA in adults are limited to large ducts. Surgical closure is indicated for large, complex forms and PDAs associated with cardiac anomalies.<sup>5</sup>

Despite the safety of interventional surgical cardiac procedures, catheter-based closure is considered the procedure of choice. However, data on adverse events beyond the immediate catheterization period are lacking.<sup>6</sup> Complications after device closure of a PDA include device embolization during the procedure or just after implantation, pericardial tamponade, erosion of cardiac structures, and pulmonary or systemic embolization resulting from device-related thrombus formation.<sup>7</sup>

The incidence of occluder device embolization after ASD closure has been reported to be 0.55% to 1.4%.<sup>8</sup> Almost one half of the embolized devices will tend to lodge in the left atrium or aorta.<sup>9</sup> A few embolized devices (16.7%) can be retrieved using a percutaneous approach.<sup>10</sup> Various investigators have reported that an embolized device should always be retrieved surgically because that will allow for inspection of any structures that might have been damaged.<sup>11</sup>

In the present case report, we have described the unusual complication and its management of embolization of a PDA correction device into the abdominal aorta after transcatheter closure of a large PDA associated with other anomalies. The patient provided written informed consent for the report of her case.

## CASE REPORT

A 24-year-old woman had presented with cyanotic heart disease, an ASD secundum ~17 mm in diameter, a large PDA 8 mm in length and 10 mm in diameter with pulmonary hypertension (dilated pulmonary artery and its branches and

---

From the Department of Vascular Surgery, Faculty of Medicine, Mansoura University.

Author conflict of interest: none.

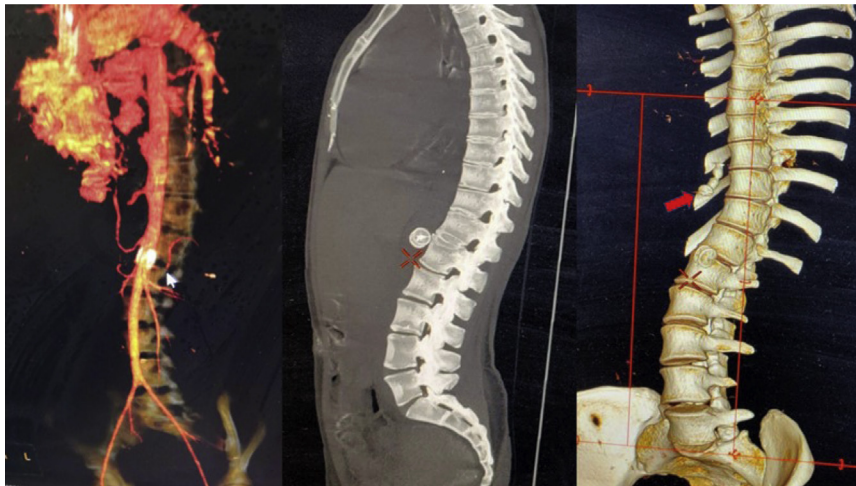
Correspondence: Mosaad Soliman, PhD, Department of Vascular Surgery, Faculty of Medicine, Mansoura University, Elgomhoria St, Mansoura 35111, Egypt (e-mail: [soliman\\_mosaad@hotmail.com](mailto:soliman_mosaad@hotmail.com)).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

© 2020 The Authors. Published by Elsevier Inc. on behalf of Society for Vascular Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jvscit.2020.10.016>



**Fig 1.** Computed tomography angiogram of aortic system showing evidence of slipped closure device at the origin of the superior mesenteric artery with good filling (*white arrow*) and the second device correctly placed at the partial anomalous right pulmonary veins (partial anomalous pulmonary venous connection [PAPVC]; *red arrow*).

moderate tricuspid regurgitation), and a PAPVC with the right pulmonary veins draining into the inferior vena cava at the level of the diaphragm. She had undergone transcatheter occlusion of the PAPVC with an Amplatzer vascular plug and occlusion of the PDA with an Amplatzer Ductal Occluder (ADO; St Jude Medical Inc, St Paul, Minn). However, 2 months after the first operation, the patient had developed chest and then abdominal pain. On examination, we observed a tender rigid abdomen, especially at the right hypochondrium, and bilateral basal crepitations. The femoral pulsations were intact on both sides. Computed tomography of the chest showed an abnormal device location at the abdominal aorta with opacification of both iliac and femoral arteries (Figs 1 and 2).

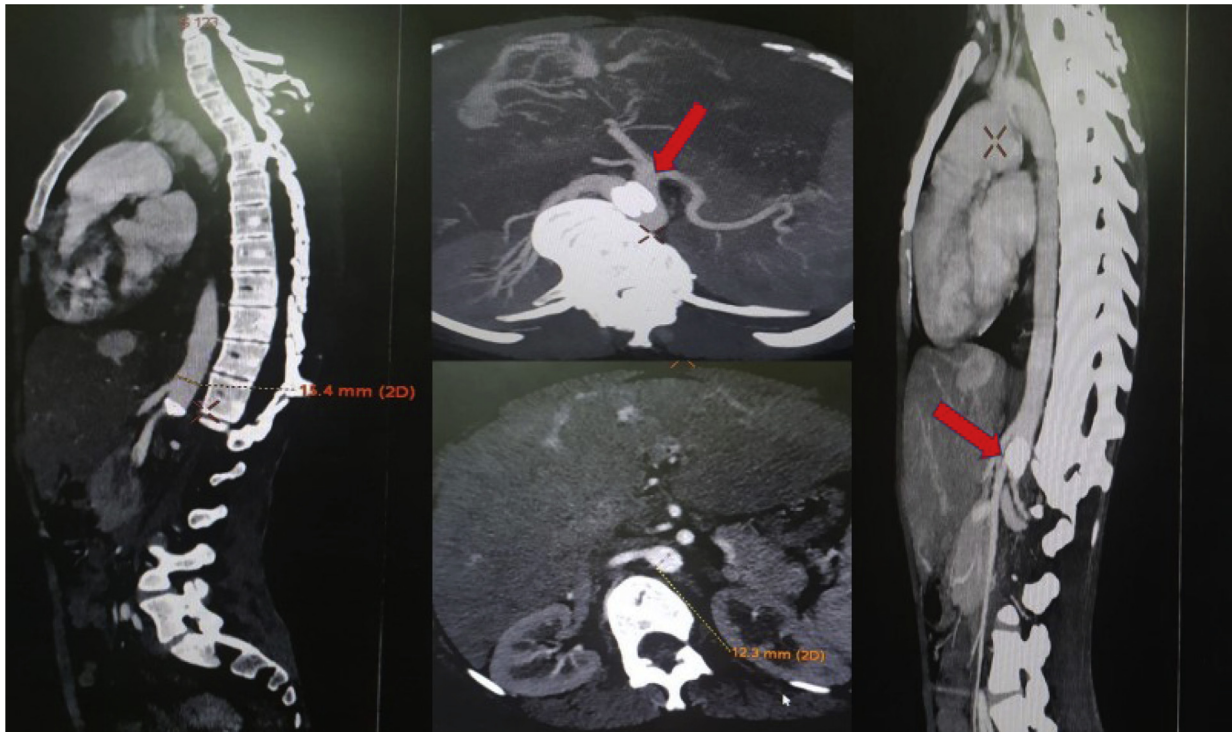
The diameter of the abdominal aorta was 12.3 mm and 15.4 mm below and above the embolized ADO (12.5 mm), respectively. The decision was made to snare the ADO through either transbrachial or femoral access. However, the challenge was the size discrepancy between the ADO and the much smaller exit site of the brachial (0.6 mm) or femoral (0.8 mm) arteries. We first attempted transfemoral access using a 6F sheath on the right side (Fig 3). However, failure to snare or disimpact the device necessitated changing to the transbrachial access using a 6F sheath that was replaced with long sheath. Aortography showed that the ADO was impacted at the level of the celiac trunk. Despite several trials to snare the ADO, the slippery characteristics of the interwoven occluder precluded this task. The device is wheel-like and had lodged in an oblique position, which increased the difficulty of snaring (Supplementary Video). We decided to change the direction of the device to a vertical position to take advantage of the wheel-like character of the ADO and dislodge and then push it down into the distal aorta. Trapping the device in the snare loop and applying a steady downward force using a 5F Bernstein catheter changed the direction of the ADO to the vertical from the inclined oblique position. We then rolled it down to the aortic bifurcation.

Abdominal exploration through a minilaparotomy was performed, and the ADO was extracted via a small aortotomy (Fig 4). Completion angiography revealed normal opacification of the superior mesenteric artery (Fig 5). The visceral viability and liver status were assessed because they had shown cyanosis and considerable liver engorgement. However, these had reversed to the normal status by the end of the procedure. The hepatic and intestinal ischemia were not reflected in the findings from the postoperative laboratory workup, probably owing to the transient and partial occlusion of the aorta and nearby visceral arteries by the lodged device.

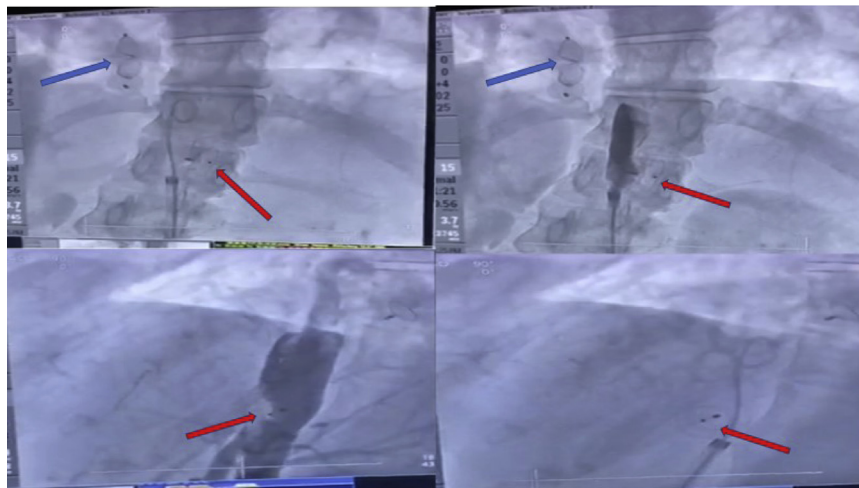
## DISCUSSION

Patients with a large PDA can present with a wide clinical spectrum ranging from an asymptomatic child to an adolescent with severe pulmonary hypertension and Eisenmenger syndrome.<sup>12</sup> The effects of a long-standing PDA-related shunt in adults with acquired cardiomyopathies or systemic illness differ from those in the pediatric population.<sup>13</sup> Our patient was 24 years old with a long-lasting and large PDA (10 mm in diameter and 8 mm in length) with severe pulmonary hypertension (pulmonary flow/systemic flow, 1.9). Nonsurgical management of large hypertensive PDAs has recently replaced surgical options, especially after infancy. Patients with hypertensive PDAs represent a special subgroup owing to the mismatch between the size of the device and the patient, the presence of severe pulmonary hypertension, and the need to insert a large device.<sup>14</sup>

Several reports on the efficacy and safety of the ADO device (St Jude Medical) have been reported. However, most had focused on the pediatric age group, with a limited number of adults included, and the follow-up duration was short or medium term.<sup>15,16</sup> Just as in cases of established Eisenmenger syndrome, the desaturation



**Fig 2.** Computed tomography angiogram of the abdominal aorta showing a diameter of 12.3 mm and 15.4 mm below and above the embolized Amplatzer Ductal Occluder (ADO; St Jude Medical; 12.5 mm; *red arrows*), respectively.



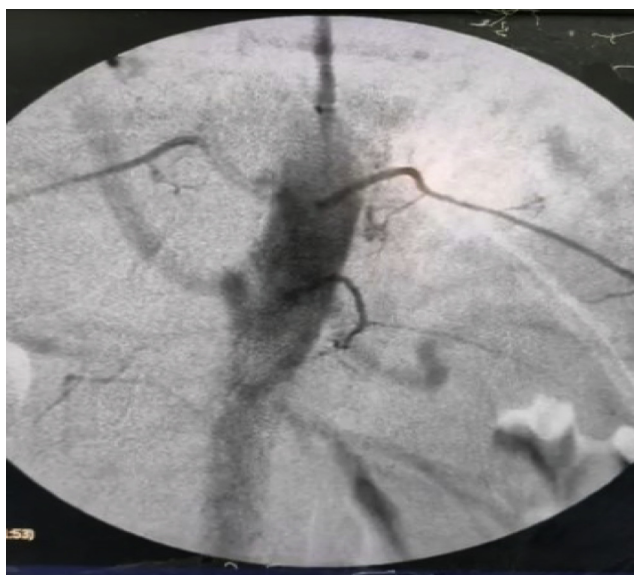
**Fig 3.** Intraoperative aortography through the femoral access showing failure of retrieval and no disimpaction of the device. *Red arrow* indicates slipped closure device at the origin of superior mesenteric artery; and *blue arrow*, the second device correctly placed at the partial anomalous right pulmonary veins (partial anomalous pulmonary venous connection [PAPVC]).

and pulmonary artery systolic pressure might not decrease even after closure of the defect. Thus, we had decided to close the PDA and PAPVC percutaneously using TCC and to leave the ASD open, shunting the blood into the systemic circulation and maintaining the cardiac output.

Severe complications have been reported after TCC of PDAs, including left pulmonary artery and aortic isthmus narrowing, hemolysis, postprocedure ventricular dysfunction, recanalization, device infection, and device embolization.<sup>17</sup> The use of an undersized device, a floppy or an inadequate rim, device malpositioning, and



**Fig 4.** Intraoperative aortography showing Amplatzer Ductal Occluder (ADO; St Jude Medical) rolled down to the aortic bifurcation (A). The ADO device was extracted through a small aortotomy via a minilaparotomy (B).



**Fig 5.** Completion angiogram showing opacification of visceral arteries after device retrieval.

excessive tension on the delivery cable during deployment are the possible mechanisms for device embolization.<sup>10</sup> Although percutaneous retrieval of an embolized device is challenging, it should be attempted first in all cases. Technical success can be achieved by using specific techniques such as the modified snare technique,<sup>18</sup> biopsy forceps retrieval through a larger femoral sheath, or the use of multiaxial snares. However, the supraceliac approach was not considered for our patient to avoid major surgical exposure and total visceral rotation with its associated morbidities. In our patient, although the chosen ADO size was correct, it had migrated owing to the severe pulmonary hypertension and had become

impacted obliquely at the level of the celiac trunk. We used the described hybrid technique, transbrachial access and a lower abdominal midline incision, to drive the device to the lower abdominal aorta, which allowed us to retrieve it without the need for total visceral rotation and to assess the visceral and hepatic viability.

We believe it might be feasible to retrieve any device embolized in the thoracic or abdominal aorta using an endovascular method, except for the larger devices. For the latter, the hybrid technique can provide a better solution because the device can be driven to a more accessible site for surgical extraction through a lower midline, lumbar, axillary, or femoral incision. These sites are less surgically traumatic than the thoracotomy and upper midline incisions. Approximately one half of reported patients had undergone percutaneous closure of the ASD after retrieval of the embolized device. However, it was not reported whether the removal and ASD closure had been performed synchronous or sequential procedures.<sup>19</sup> The present case was referred back to her pediatric cardiologist for ASD correction at the appropriate time in accordance with their protocol.

## CONCLUSIONS

Device embolization and acute abdomen is a rare complication of transcatheter PDA closure. The hybrid approach we have described overcomes the limitations of either approach when used alone.

## REFERENCES

1. Van der Linde D, Konings EE, Slager MA, Witsenburg M, Helbing WA, Takkenberg JJ, et al. Birth prevalence of congenital heart disease worldwide: a systematic review and meta-analysis. *J Am Coll Cardiol* 2011;58:2241-7.
2. Bernier PL, Stefanescu A, Samoukovic G, Tchervenkov CI. The challenge of congenital heart disease worldwide:

- epidemiologic and demographic facts. *Semin Thorac Cardiovasc Surg Pediatr Card Surg Annu* 2010;13:26-34.
3. Pandya B, Cullen S, Walker F. Congenital heart disease in adults 2016;354:i3905.
  4. Dillman JR, Yarram SG, Hernandez RJ. Imaging of pulmonary venous developmental anomalies. *AJR Am J Roentgenol* 2009;192:1272-85.
  5. Putra ST, Djer MM, Idris NS, Sastroasmoro S. Transcatheter closure of patent ductus arteriosus in adolescents and adults: a case series. *Acta Med Indones* 2016;48:314-9.
  6. El-Said HG, Bratincsak A, Foerster SR, Murphy JJ, Vincent J, Holzer R, et al. Safety of percutaneous patent ductus arteriosus closure: an unselected multicenter population experience. *J Am Heart Assoc* 2013;2:e000424.
  7. Abaci A, Unlu S, Alsancak Y, Kaya U, Sezenoz B. Short and long term complications of device closure of atrial septal defect and patent foramen ovale: meta-analysis of 28,142 patients from 203 studies. *Catheter Cardiovasc Interv* 2013;82:1123-38.
  8. Amanullah MM, Siddiqui MT, Khan MZ, Atiq MA. Surgical rescue of embolized Amplatzer devices. *J Cardiac Surg* 2011;26:254-8.
  9. DiBardino DJ, McElhinney DB, Kaza AK, Mayer JE Jr. Analysis of the US Food and Drug Administration manufacturer and user facility device experience database for adverse events involving Amplatzer septal occluder devices and comparison with the Society of Thoracic Surgery congenital cardiac surgery database. *J Thorac Cardiovasc Surg* 2009;137:1334-41.
  10. Moore J, Hegde S, El-Said H, Beekman R III, Benson L, Bergersen L, et al. Transcatheter device closure of atrial septal defects: a safety review. *JACC Cardiovasc Interv* 2013;5:433-42.
  11. Kim JJ, Hijazi ZM. Clinical outcomes and costs of Amplatzer transcatheter closure as compared with surgical closure of ostium secundum atrial septal defects. *Med Sci Monit* 2002;8:787-91.
  12. Moore P, Brook M, Heymann M. Patent ductus arteriosus and aortopulmonary window. In: Allen H, Driscoll D, Shaddy R, Feltes T, editors. *Moss and Adams' Heart Disease in Infant Children and Adolescent*. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2008. p. 683-702.
  13. Sommer RJ, Hijazi ZM, Rhodes JF Jr. Pathophysiology of congenital heart disease in the adult: part I: shunt lesions. *Circulation* 2008;117:1090-9.
  14. Shah JH, Bhalodiya DK, Rawal AP, Nikam TS. Long-term results of transcatheter closure of large patent ductus arteriosus with severe pulmonary arterial hypertension in pediatric patients. *Int J Appl Basic Med Res* 2020;10:3-7.
  15. Gruenstein DH, Ebeid M, Radtke W, Moore P, Holzer R, Justino H. Transcatheter closure of patent ductus arteriosus using the AMPLATZER™ duct occluder II (ADO II). *Catheter Cardiovasc Interv* 2017;89:1118-28.
  16. Kudumula V, Taliotis D, Duke C. The new occlutech duct occluder: immediate results, procedural challenges, and short-term follow-up. *J Invasive Cardiol* 2015;27:250-7.
  17. Sudhakar P, Jose J, George OK. Contemporary outcomes of percutaneous closure of patent ductus arteriosus in adolescents and adults. *Indian Heart J* 2018;70:308-15.
  18. Chan KT, Cheng BC. Retrieval of an embolized Amplatzer septal occluder. *Catheter Cardiovasc Interv* 2010;75:465-8.
  19. Levi DS, Moore JW. Embolization and retrieval of the Amplatzer septal occlude. *Catheter Cardiovasc Interv* 2004;61:543-7.

Submitted Jun 30, 2020; accepted Oct 8, 2020.