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Case Report | Open Access

Surgical retrieval of an embolized Amplatzer™ ductal occluder device with review of comparable cases

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ABSTRACT

Well-known complications of transcatheter shunt closure interventions are embolizations of devices. The initial procedure after embolization of a device is transcatheter interventions such as repositioning or retrieval with a sheath, bioptome or a snare. In some cases, surgical procedures may require and be privileged to reduce the harm to the patient. In this article, we report an eight-year-old boy who underwent surgical retrieval of Amplatzer™ Duct Occluder I device from the left pulmonary artery without cardiopulmonary bypass and discuss the safe retrieval techniques of commonly used devices.

Keywords: Catheter complications, device embolization, ductal occluder, surgical retrieval.

In recent years, interventional transcatheter device closure has become the most favorite treatment modality in congenital heart diseases. However, it can occasionally lead to catastrophic complications such as embolization. Although transcatheter retrieval is the first choice, surgical techniques may be inevitable in some cases. Herein, we report a surgical retrieval procedure of an embolized Amplatzer™ duct occluder (ADO) (Abbott Structural Heart, Plymouth, MN, USA) from the left pulmonary artery without cardiopulmonary bypass in the light of literature review.

CASE REPORT

An eight-year-old male patient with a known patent ductus arteriosus (PDA) was admitted for percutaneous device closure. Echocardiography revealed a tubular PDA 6.4 mm in diameter and 21 mm in length, with moderate pulmonary hypertension and left ventricular dilatation. He underwent right heart catheterization which identified a 10-mm PDA. The hemodynamic data showed a mean pulmonary artery pressure of 34 mmHg, with a mean aortic pressure of 55 mmHg. The Qp/Qs ratio was 2.89 and Rp/Rs ratio was 0.09. Balloon occlusion showed a drop in pulmonary pressures to half of systemic and a 12×10 mm ADO I device (Abbott Structural Heart, Plymouth, MN, USA) was positioned with success. Within few hours of deployment, control telecardiogram and echocardiography revealed that the device was embolized into the left pulmonary artery (Figure 1). The initial plan was to retrieve the device angiographically with percutaneous technique. Several attempts with 5Fr Judkins and 5Fr Multipurpose catheters failed.

The patient was immediately transferred to the operating room. Median sternotomy was performed. He was hemodynamically stable. Aorta, pulmonary artery, and PDA were dissected. The device was fell in the left pulmonary artery. The distal end was controlled with snares and occluded, and the proximal part of left pulmonary artery was cross-clamped and an arteriotomy over the device was performed. We removed the device successfully without any complication. The PDA was ligated with the Ethibond® suture and transfixed. The pulmonary artery was primarily repaired using 5-0 prolene sutures. After the operation, the patient was

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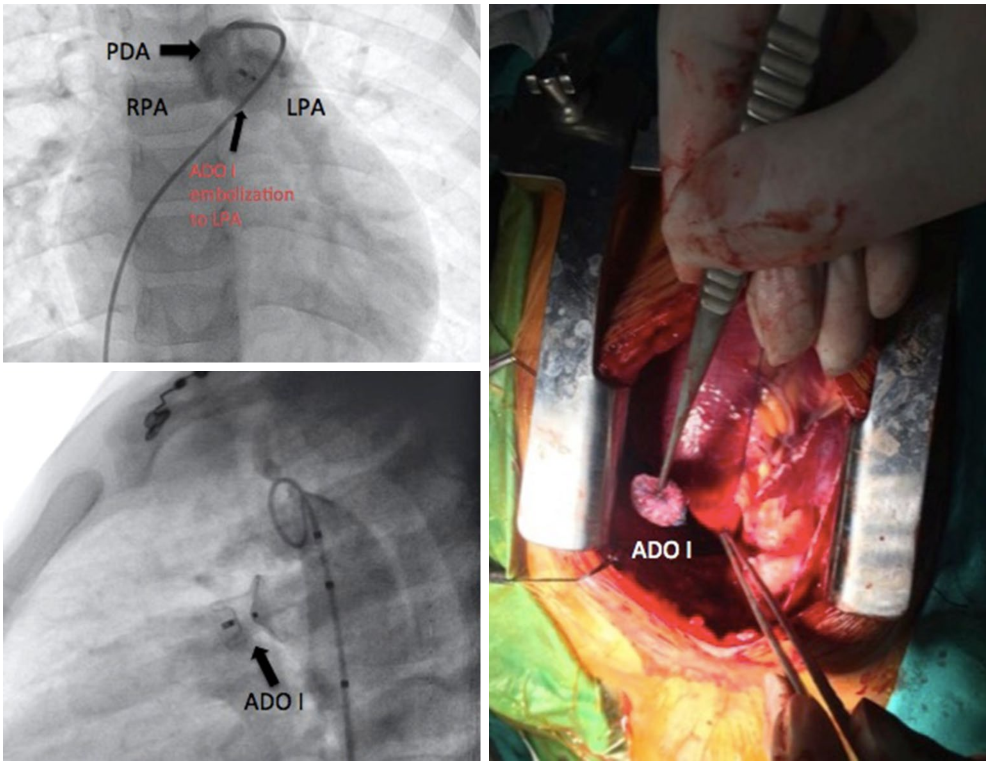

Figure 1. Angiographical and intraoperative images showing embolized device.

transferred to cardiac intensive care unit, extubated within few hours, and discharged home on the third postoperative day with full recovery. Follow-up echocardiogram showed no flow across the ductus arteriosus, no residual defect, and no peripheral pulmonary arterial stenosis. A written informed consent was obtained from the parents and/or legal guardians of the patient.

DISCUSSION

Transcatheter PDA closure was first applied in 1967 and the procedure became more practical. There have been many dramatic improvements and, over the last two decades, transcatheter approaches has become the considerable.[1]

Anatomical varieties, calcification and aneurysm formation, left ventricular dysfunction and pulmonary hypertension may complicate transcatheter closure of PDA.[2]

Currently, in most age groups, except premature infants, transcatheter therapy for persistent flow through the arterial duct is accepted as a well-established alternative. The design of occluder devices has been improved regarding the occlusion rate, stability, and smaller sizes of delivery systems. The initial ADO can accomplish high rates of occlusion with minimum complications in different sizes and morphology of ducts and age groups.[3]

There are several factors which affect the performance of transcatheter device closure of PDA such as vascular accessibility, anatomical structure of the ductus, and selecting optimal device. The ADO II devices (Abbott Structural Heart, Plymouth, MN, USA) are the proper for retrograde aortic approach. Small-sized ducts are convenient for coils, and occluders are usually used for larger ones.[4]

Severe complications such as embolization, infection, hemolysis, protrusion into aorta or pulmonary artery causing obstruction or narrowing, spontaneous recanalization and post-procedure left ventricular systolic dysfunction have been defined after percutaneous techniques.[5,6]

The role of all transcatheter closure procedures of intracardiac and extracardiac shunts has gained

Table 1
Review of the literature on surgical retrieval of embolized devices

No	Author	Year	Patient age	Sex	Diagnosis	Embolized device and size (mm)	Embolization site	Surgical retrieval technique
1	Verma et al.[14]	2003	10 years	Female	ASD	ASO (14 mm) (AGA Medical Corp., Golden Valley, Minnesota, USA)	Left ventricle	Median sternotomy, with CPB
2	McMullan et al.[11]	2007	11.5 months		PDA	ADO (6-4 mm) (AGA Medical Corp., Golden Valley, Minnesota, USA)	Descending aorta	Left posterolateral thoracotomy, without CBP
3	Misra et al.[15]	2007	18 years	Male	ASD	Blockaid septal occluder device (28 mm) (Alloy Comp, Shangai, China)	Pulmonary artery	Median sternotomy, with CPB
4	Aydin and Ozisik[16]	2009	4 months	Female	PDA	Transcatheter coil (Ductocclud, PPM coil, PFM AG, Cologne, Germany)	Left pulmonary artery	Left thoracotomy, without CPB
5	Amanullah et al.[17]	2011	16 years 53 years 6 months 4 years	Female Female Male Female	ASD ASD PDA PDA	ASO (36 mm) ASO ADO (4-6 mm) Amplatzer muscular ventricular septal defect occluder (12 mm)	Right ventricle Ascending aorta Descending aorta Right pulmonary artery	Sternotomy, with CPB Sternotomy, with CPB Left thoracotomy, without CPB Sternotomy, with CPB
6	Yuce et al.[18]	2011	44 years	Male	ASD	ASO (26 mm) (AGA Medical Corp., Golden Valley, Minnesota, USA)	Right ventricle	Median sternotomy, with CPB
7	Gokaslan et al.[13]	2012	4 years 8 years 9 years 15 years 15 years 9 years 8 years 2 years 10 years		ASD ASD ASD ASD ASD ASD PDA PDA Muscular VSD	ASO (38-34 mm) ASO (32-36 mm) ASO (36-40 mm) ASO (29-33 mm) ASO (38-42 mm) Biostar BSR-28 ADO (10-8 mm) Amplatzer Nit. Ocluder (9-6) Amplatzer VSDmusc (16 mm)	Tricuspid valve Right ventricle Left ventricle Pulmonary valve Right atrium Tricuspid valve Ascending aorta Tricuspid valve Tricuspid valve	Sternotomy, with CBP
8	Son and Park[19]	2012	45 years	Female	ASD	ASO (32 mm)	Right pulmonary artery	Median sternotomy, with CPB
9	Tai et al.[20]	2014	22 years		VSD	HeartR membVSD Occl.(4)	Iliac artery	Laparatomy
10	Cianciulli et al.[21]	2014	66 years	Male	ASD	ASO (22 mm)	Left ventricle	Median sternotomy, with CPB
11	Tang et al.[22]	2014	12 months	Female	PDA	ADO (6-8 mm)	Descending aorta	Posterolateral thoracotomy
12	Gumus et al.[23]	2014	5 years	Female	PDA	ADO (6-8 mm)	Abdominal aorta	Laparatomy
13	Celik et al.[24]	2016	35 years	Female	ASD	ASO (13.5 mm) (Occlutech Figulla Flex II)	Abdominal aorta	Laparatomy
14	Nath and Pandit[25]	2016	48 years	Female	ASD	ASO (30 mm)	Right ventricle	Median sternotomy, with CPB
15	Davies et al.[26]	2017	58 years	Male	PFO	Amplatzer fenestrated ASO (30 mm)	Visceral abdominal aorta	Laparotomy
16	Kumar et al.[27]	2017	11 years	Male	Coronary-cameral fistula (RCA to RV)	Amplatzer vascular plug (10×7 mm)	Left pulmonary artery	Median sternotomy, with CPB
17	Georgiev et al.[28]	2018	24 years 25 years	Female Female	ASD ASD	ASO (28 mm) Occlutech (28 mm)	LVOT PA	Median sternotomy, with CPB Median sternotomy, with CPB
18	Şişli and Epçaçan[29]	2019	11 months	Female	PDA	ADO II (5/4 mm) (St.Jude Medical Corp., Plymouth, MN, USA)	Right common iliac artery	Laparatomy, PTFE tube graft interposition
19	Sun et al.[30]	2020	2 years	Male	PDA	ADO	Bulged out of descending aorta (Iatrogenic CoA)	Posterolateral thoracotomy, with CPB

ASD: Atrial septal defect; PDA: Patent ductus arteriosus; VSD: Ventricular septal defect; PFO: Patent foramen ovale.

importance in recent years as PDA closure. These procedures eliminate the need for sternotomy and cardiopulmonary bypass and shortens the length of hospital stay.[7] Although percutaneous techniques become popular due to less mortality and morbidity rates and early discharge from hospital, they are not free of complications. Device embolizations in different sites of circulatory system may cause life-threatening damages. In the literature, device embolization rates were 4% in 1991, 20% in 1996, and 0.55% in 2005.[8,9] New generation devices significantly decreased serious complications.[8,9] However, embolized devices which require urgent surgical management are still reported and majority of these are case reports.[10,11]

In the literature, from 72 embolization cases between years 2000 and 2020, 40 of them were atrial septal defects, 17 were PDA, nine were ventricular septal defects, three were patent foramen ovale with neurological symptoms and signs, one was mitral paravalvular leak, one was coronary-cameral fistula, and one was ascending aorta pseudoaneurysm. The most frequently embolization site of the device was pulmonary artery, similar to our case. In the relevant literature, device removal or repositioning was achieved mostly through the percutaneous route. A total of 49 of 71 cases were rescued via transcatheter techniques. Twenty-three patients underwent surgical procedure. All embolized devices were successfully retrieved both surgically and angiographically (Table 1).

In hemodynamically stable cases, the first choice is to attempt percutaneous rescue methods. The retrieval of an embolized device from the pulmonary artery by snaring technique has been described and there are various reports regarding the successful retrieval devices either by surgery, a percutaneous method using various snares or bioptomes, or by a sheath in the sheath technique.[12,13]

After device embolization, the main goal is to localize the embolized device into a harmless position. Operators using transcatheter occluder devices should be familiar with performing percutaneous retrieval techniques. However, in life-threatening cases, it should not be late for recognition and surgical intervention. It is also important to consider late embolization of devices and close follow-up with X-ray and control echocardiograms to realize earlier. The literature strongly suggests that these devices should be only inserted in facilities, where back-up of pediatric cardiovascular surgical cover, operating room, and blood product preparations are immediately available. Although the embolizations seem to be rare, the results may be destructive such as extremity loss, mortality or, at least in the best-case scenario, recurrent surgical and/or endovascular interventions may be required.[14]

In conclusion, although transcatheter closure is applicable and advantageous even in the lowest weight infants, there are absolutely many serious catheterization-related risks, as the patient size becomes smaller. Further improvements would advance the safety and utility of transcatheter procedures.

Declaration of conflicting interests

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REFERENCES

1. Baumgartner H, Bonhoeffer P, De Groot NM, de Haan F, Deanfield JE, Galie N, et al. ESC Guidelines for the management of grown-up congenital heart disease (new version 2010). Eur Heart J 2010;31:2915-57.
2. Yan C, Zhao S, Jiang S, Xu Z, Huang L, Zheng H, et al. Transcatheter closure of patent ductus arteriosus with severe pulmonary arterial hypertension in adults. Heart 2007;93:514-8.
3. Sivakumar K, Francis E, Krishnan P. Safety and feasibility of transcatheter closure of large patent ductus arteriosus measuring ≥4 mm in patients weighing ≤6 kg. J Interv Cardiol 2008;21:196-203.
4. 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.
5. Azhar AS, Abd El-Azim AA, Habib HS. Transcatheter closure of patent ductus arteriosus: Evaluating the effect of the learning curve on the outcome. Ann Pediatr Cardiol 2009;2:36-40.
6. Jang GY, Son CS, Lee JW, Lee JY, Kim SJ. Complications after transcatheter closure of patent ductus arteriosus. J Korean Med Sci 2007;22:484-90.
7. Yücel İK, Ballı Ş, Çelebi A. Transcatheter closure of an aortico-left ventricular tunnel using Amplatzer® Vascular Plug II. Turk Gogus Kalp Dama 2016;24:748-51.
8. Worms AM, Rey C, Bourlon F, Losay J, Marçon F, Godart F, et al. French experience in the closure of atrial septal defects of the ostium secundum type with the Sideris button occluder. Arch Mal Coeur Vaiss 1996;89:509-15.

9. Tan CA, Levi DS, Moore JW. Embolization and transcatheter retrieval of coils and devices. Pediatr Cardiol 2005;26:267-74.
10. Shahabuddin S, Atiq M, Hamid M, Amanullah M. Surgical removal of an embolised patent ductus arteriosus amplatzer occluding device in a 4-year-old girl. Interact Cardiovasc Thorac Surg 2007;6:572-3.
11. McMullan DM, Moulick A, Jonas RA. Late embolization of Amplatzer patent ductus arteriosus occlusion device with thoracic aorta embedment. Ann Thorac Surg 2007;83:1177-9.
12. Baruteau AE, Hascoët S, Baruteau J, Boudjemline Y, Lambert V, Angel CY, et al. Transcatheter closure of patent ductus arteriosus: Past, present and future. Arch Cardiovasc Dis 2014;107:122-32.
13. Gokaslan G, Ustunsoy H, Deniz H, Ozcaliskan O, Yasim A, Baspinar O, et al. Urgent surgical management for embolized occluder devices in childhood: Single center experience. J Cardiothorac Surg 2012;7:127.
14. Verma PK, Thingnam SK, Sharma A, Taneja JS, Varma JS, Grover A. Delayed embolization of Amplatzer septal occluder device: An unknown entity--a case report. Angiology 2003;54:115-8.
15. Misra M, Sadiq A, Namboodiri N, Karunakaran J. The 'aortic rim' recount: Embolization of interatrial septal occluder into the main pulmonary artery bifurcation after atrial septal defect closure. Interact Cardiovasc Thorac Surg 2007;6:384-6.
16. Aydin H, Ozisik K. Surgical removal of an embolized patent ductus arteriosus coil from pulmonary artery without cardiopulmonary bypass. Interact Cardiovasc Thorac Surg 2009;8:689-90.
17. Amanullah MM, Siddiqui MT, Khan MZ, Atiq MA. Surgical rescue of embolized amplatzer devices. J Card Surg 2011;26:254-8.
18. Yuce M, Ozer O, Cakici M, Cine N, Sari I, Davutoglu V. Embolized Amplatzer septal occluder device presenting with ventricular fibrillation. Cardiovasc Revasc Med 2011;12:131-2.
19. Son JW, Park JS. Subacute, silent embolization of amplatzer atrial septal defect closure device to the pulmonary artery. J Cardiovasc Ultrasound 2012;20:201-4.
20. Tai S, Tang L, Zhu ZW, Fang ZF, Hu XQ, Tang JJ, et al. Embolisation of perimembranous ventricular septal defect occluder and transcatheter retrieval. Heart Lung Circ 2014;23:951-6.
21. Cianciulli TF, Redruello HJ, Rubio MA, Poveda Camargo RL, Granja MA, Barrero CM, et al. Surgical rescue of embolized amplatzer septal occluder. Can J Cardiol 2014;30:465.e3-4.
22. Tang L, Zhou S, Shen X. Severe spinal cord ischemic injury secondary to device embolization after transcatheter closure of a patent arterial duct. Tex Heart Inst J 2014;41:83-6.
23. Gümüş F, Tasar M, Ada F, Eyileten Z, Yazıcıoğlu L, Kaya B, et al. Open abdominal surgery for migration of patent ductus arteriosus occluder device. Cardiovascular Surgery and Interventions 2014;1:23-5.
24. Celik T, Ozturk C, Bozlar U, Iyisoy A. Late embolization of the atrial septal occluder device into the abdominal aorta. Indian Heart J 2016;68:200-1.
25. Nath RK, Pandit N. Asymptomatic late embolization of Amplatzer septal occluder device. Indian Heart J 2017;69:338-40.
26. Davies AJ, Collins N, Organ N. Retrieval of embolized Amplatzer patent foramen ovale occlusion device: Issues related to late recognition. Case Rep Cardiol 2017;2017:9894215.
27. Kumar B, Kumar A, Kumar G, Singh H. Role of transesophageal echocardiography in surgical retrieval of embolized amplatzer device and closure of coronary-cameral fistula. Ann Card Anaesth 2017;20:351-4.
28. Georgiev S, Tanase D, Genz T, Ewert P, Naumann S, Pozza RD, et al. Retrieval of large Occlutech Figula Flex septal defect occluders using a commercially available bioptome: Proof of concept. Cardiol Young 2018;28:955-60.
29. Şişli E, Epçaçan S. An attempt to retrieve an embolized ductal closure device leading to iliac artery dissection in an 11-month-old child: A case report. Turk Gogus Kalp Damar Cerrahisi Derg 2018;27:111-3.
30. Sun Z, Li D, Wang Y, An Q. Surgical removal of part of an occluder to treat iatrogenic coarctation of the aorta: A case report. BMC Surg 2020;20:17.