INTRODUCTION

Atrial septal defects (ASDs) are the most common congenital heart lesions in adults. Following the first case of ASD closure in 1974 by Lock [1], percutaneous ASD closure has been increasingly applied instead of traditional surgical closure. Despite its many advantages, including the safety of the procedure, major complications such as device embolization, cardiac erosions, new-onset atrial arrhythmia, and thromboembolism have been reported [2,3]. Herein, we report a case of displacement of an ASD occlusion device following percutaneous ASD closure. The study was approved by the Institutional Review Board of the Seoul National University Hospital (IRB no. H-2206-010-1328).

CASE

A 29-year-old female was referred for evaluation after echocardiographic follow-up following percutaneous device closure of an ASD 3 months prior. She had a history of heart valve surgery when she was 15 months old; however, she did not remember the diagnosis made at that time. She had been diagnosed with a 10.1 mm×6 mm sized, oval-shaped secundum ASD with a left-to-right shunt and right-sided heart enlargement at a recent health screening. Due to the septal defect, the patient underwent transcatheter closure using a 10.5-mm Figulla Flex II ASD (FSO, Occlutech GmbH, Jena, Germany) occluder. As in the routine procedure, the guidewire and delivery sheath were introduced into the femoral vein via a small incision in the groin. Under transesophageal echocardiography (TEE) guidance, the ASD occluder was introduced through the delivery sheath of a semi-rigid cable and placed in the ASD. After extending the device to the ASD, it was released by the catheter. The patient was discharged without any immediate postoperative complications, with a prescription of aspirin (100 mg/d) and clopidogrel (75 mg/d), and optimal placement was checked using transthoracic echocardiography (TTE) and chest radi-
Two months after ASD closure, TTE and chest radiography revealed the absence of the device in the ASD. Device migration was subsequently diagnosed using computed tomography angiography, which revealed the presence of the ASD occluder at the aortic bifurcation (Fig. 1, 2). The patient had no symptoms, such as dyspnea, chest discomfort, or leg ischemia, and was referred to the vascular surgery team due to the risk of aortic perforation or thrombosis. The device was removed the next day via a transabdominal approach through a 2-cm transverse incision made 1 cm above the aortic bifurcation, with clamping aorta and both iliac arteries (Fig. 3). The removed device showed no abnormalities in structural integrity (Fig. 4). The aortic wall was closed with a simple primary suture. The aortic cross-clamp time for device removal was 9 minutes, and the total operative time was 120 minutes. The patient stayed in the intensive care unit for 24 hours postoperatively and was discharged without any immediate postoperative complications on postoperative day 6. The cardiologist determined that further ASD closure was not required as a current emergency. Instead, he decided to perform a routine follow-up and implement additional plans if complications, such as progression of right ventricle enlargement, occurred. Outpatient follow-up at 1 year revealed no specific findings on echocardiography. Thereafter, follow-up was planned every 2 years.

**DISCUSSION**

Several devices have been approved and are in clinical use for percutaneous closure of secundum ASDs. Each de-
Surgical Removal of Migrated ASD Closure Device

Aortic arch

Several mo - 6 mo

Helex

Transabdominal approach

OFSO

Laparoscopic extraction

Descending aorta

Level of iliac bifurcation

Right external iliac artery

Bilateral anterior thoracotomies (clamshell incision)

Ascending aorta

>2 y after

Median sternotomy

Aortic arch

Several mo

Transabdominal approach

Table 1. Case reports of surgical removal of migrated atrial septal defect occluder in abdominal aorta

| Reference            | Device   | Migration to          | Migration found | Approach                                      |
|----------------------|----------|-----------------------|-----------------|-----------------------------------------------|
| Berdat et al. [13]   | -        | Iliac vein            | -               | -                                             |
| Deşer and Demirağ [14]| ASO      | Level of iliac bifurcation | 1 mo          | Medial laparotomy                             |
| Colacchio et al. [16]| Helex    | Level of aortic bifurcation | 6 mo          | Laparoscopic extraction                       |
| Jahrome et al. [17]  | OFSO     | Level of the celiac axis | 5 mo          | Medial laparotomy                             |
| Ferrero et al. [15]  | ASO      | Right external iliac artery | 1st TEE follow-up | -                                             |
| Kim et al. [18]      | ASO      | Descending aorta      | 12 mo          | Bilateral anterior thoracotomies (clamshell incision) |
| Grayburn et al. [19] | ASO      | Ascending aorta       | >2 y after      | Median sternotomy                             |
| Kallstrom et al. [20]| ASO      | Aortic arch           | Several mo      | -                                             |
| Snijder et al. [5]   | ASO      | Below aortic bifurcation | 6 mo          | Transabdominal approach                       |

ASO, Amplatzer septal occluder; OFSO, Occlutech Figulla septal occluder; TEE, transesophageal echocardiography.
12-lead electrocardiogram, chest radiography, and TTE were performed at 1, 3, 6, and 12 months and thereafter every year. According to the case reported by Cotts et al. [7] (device migration to the right atrium 13 years after the closure) percutaneous closure-related complications can occur even after a few years. Therefore, long-term follow-up, including TEE or TTE, is required.

In conclusion, this case report indicates that surgical removal of a migrated ASD occluder can be performed safely without complications; therefore, it can be used as an alternative in patients in whom endovascular removal cannot be performed.

ACKNOWLEDGEMENTS

We would like to thank Professor Myungsu Lee for providing us with opinions on endovascular treatment.

FUNDING

None.

REFERENCES

1) King TD, Thompson SL, Steiner C, Mills NL. Secundum atrial septal defect. Nonoperative closure during cardiac catheterization. JAMA 1976;235:2506-2509.
2) Chessa M, Caminati M, Butera G, Bini RM, Drago M, Rosti L, et al. Early and late complications associated with transcatheter occlusion of secundum atrial septal defect. J Am Coll Cardiol 2002;39:1061-1065.
3) Yang MC, Wu JR. Recent review of transcatheter closure of atrial septal defect. Kaohsiung J Med Sci 2018;34:363-369.
4) Roymanee S, Promphan W, Tonklang N, Wongwaitaweewong K. Comparison of the Occlutech Figulla® septal occluder and Amplatzer® septal occluder for atrial septal defect device closure. Pediatr Cardiol 2015;36:935-941.
5) Snijder RJR, Renes LE, Bosshardt D, Suttorp MJ, Ten Berg JM, Post MC. Percutaneous atrial septal defect closure using the Occlutech Figulla device in adults: more than 800 patient-years of follow-up. J Interv Cardiol 2020;2020:7136802.
6) Martínez-Quintana E, Rodriguez-González F. Risks factors for atrial septal defect occlusion device migration. Int J Angiol 2016;25:e63-e66.
7) Cotts T, Strouse PJ, Graziano JN. Late migration of a Sideris buttoned device for occlusion of atrial septal defect. Catheter Cardiovasc Interv 2006;68:754-757.
8) Misra M, Sadig 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;6:384-386.
9) Amin Z, Hijazi ZM, Bass JL, Cheatham JP, Hellenbrand WE, Kleinman CS. Erosion of Amplatzer septal occluder device after closure of secundum atrial septal defects: review of registry of complications and recommendations to minimize future risk. Catheter Cardiovasc Interv 2004;63:496-502.
10) Mashman WE, King SB, Jacobs WC, Ballard WL. Two cases of late embolization of Amplatzer septal occluder devices to the pulmonary artery following closure of secundum atrial septal defects. Catheter Cardiovasc Interv 2005;65:588-592.
11) Levi DS, Moore JW. Embolization and retrieval of the Amplatzer septal occluder. Catheter Cardiovasc Interv 2004;61:543-547.
12) Ussia GP, Abella R, Pome G, Vilchez PO, De Luca F, Frigiola A, et al. Chronic embolization of an atrial septal occluder device: percutaneous or surgical retrieval? A case report. J Cardiovasc Med (Hagerstown) 2007;8:197-200.
13) Berdat PA, Chatterjee T, Pfammatter JP, Windecker S, Meier B, Carrel T. Surgical management of complications after transcatheter closure of
an atrial septal defect or patent foramen ovale. J Thorac Cardiovasc Surg 2000;120:1034-1039.

14) Deşer SB, Demirağ MK. Migration of an atrial septal occluder device with formation of abdominal aortic dissection. Ann Thorac Surg 2017;103:e343-e344.

15) Ferrero E, Ferri M, Viazzo A, Beqaraj F, Gibello L, Berardi G, et al. Migration of an AMPLATZER atrial septal occluder to the abdominal aorta. Am J Cardiol 2013;112:612-613.

16) Colacchio G, Sciannelli V, Palena G, Coggia M. Total laparoscopic intra-aortic foreign body retrieval. Eur J Vasc Endovasc Surg 2008;35:737-738.

17) Jahrome AKh, Stella PR, Leijdekkers VJ, Guyomi SH, Moll FL. Abdominal aortic embolization of a Figulla atrial septum occluder device, at the level of the celiac axis, after an atrial septal defect closure: hybrid attempt. Vascular 2010;18:59-61.

18) Kim HH, Yi GJ, Song SW. Late migration of Amplatzer septal occluder device to the descending thoracic aorta. Korean J Thorac Cardiovasc Surg 2017;50:47-49.

19) Grayburn PA, Schwartz B, Anwar A, Hebeler RF Jr. Migration of an amplatzer septal occluder device for closure of atrial septal defect into the ascending aorta with formation of an aorta-to-right atrial fistula. Am J Cardiol 2005;96:1607-1609.

20) Kallstrom E, Kallus E, Bakshi S. Migration of an atrial septal occluder device to the transverse aortic arch detected with echocardiography. J Diagn Med Sonogr 2017;33:210-215.