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CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CASE REPORT: CLINICAL CASE

Transcatheter Extraction of a Migrated Left Atrial Appendage Occluder Device

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ABSTRACT

A 69-year-old man presented at 10 weeks postimplantation with a 31-mm Watchman FLX migrating into the left atrium. Due to incomplete left atrial appendage seal and embolization risk, transcatheter device extraction was performed without complications. Herein we describe the technique and procedural steps, using cardiac computed tomography and benchtop models to guide practice. (JACC Case Rep 2024;29:102443) © 2024 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 69-year-old man was referred for left atrial appendage occlusion (LAAO) at an outside institution due to occupational limitations of chronic oral anticoagulation. He underwent implantation of a 31-mm Watchman FLX (Boston Scientific), in which intraoperative transesophageal echocardiography (TEE) demonstrated a shallow left atrial appendage (LAA) with a maximal ostial diameter measuring 25 mm (**Figure 1**) with an average depth of 23 mm. The patient was in sinus rhythm at the time of implantation with an intraprocedural mean left atrial (LA) pressure of 16 mm Hg. Although a 27-mm device was initially attempted, operative notes report a 31-mm device was ultimately implanted, achieving a compression ratio of 16% to 23% and clearing the PASS (position, anchor, size, and seal) release criteria (**Figure 2**). There were no procedural complications, and the patient was discharged on oral anticoagulation (OAC) until LAA closure could be verified with follow-up TEE.

LEARNING OBJECTIVES

- To recognize the risk, mechanisms, and potential complications of left atrial appendage occlusion device embolization.
- To highlight the importance of using cardiac computed tomography in preprocedural planning and developing real-to-life benchtop models to refine innovative structural heart interventions.
- To outline procedural steps and considerations for transcatheter extraction of a migrated and/or embolized left atrial appendage occluder device.

The patient, otherwise asymptomatic, underwent TEE at 10 weeks postimplantation, which showed significant proximal migration of the implanted device into the LA (**Figure 3**).

Given device migration with loss of seal and risk of embolization, the patient was referred to our structural heart clinic for evaluation of device removal options.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

CEP = carotid embolic protection

CT = computed tomography

LA = left atrial/atrium

LAA = left atrial appendage

LAAO = left atrial appendage occlusion

OAC = oral anticoagulation

SGC = steerable guide catheter

TEE = transesophageal echocardiography

PAST MEDICAL HISTORY

The patient's previous medical history included paroxysmal atrial fibrillation (CHA_2DS_2-VASc score 2) with prior ablation, nonischemic cardiomyopathy with an ejection fraction of 35%, hypertension, and obstructive sleep apnea.

DIFFERENTIAL DIAGNOSIS

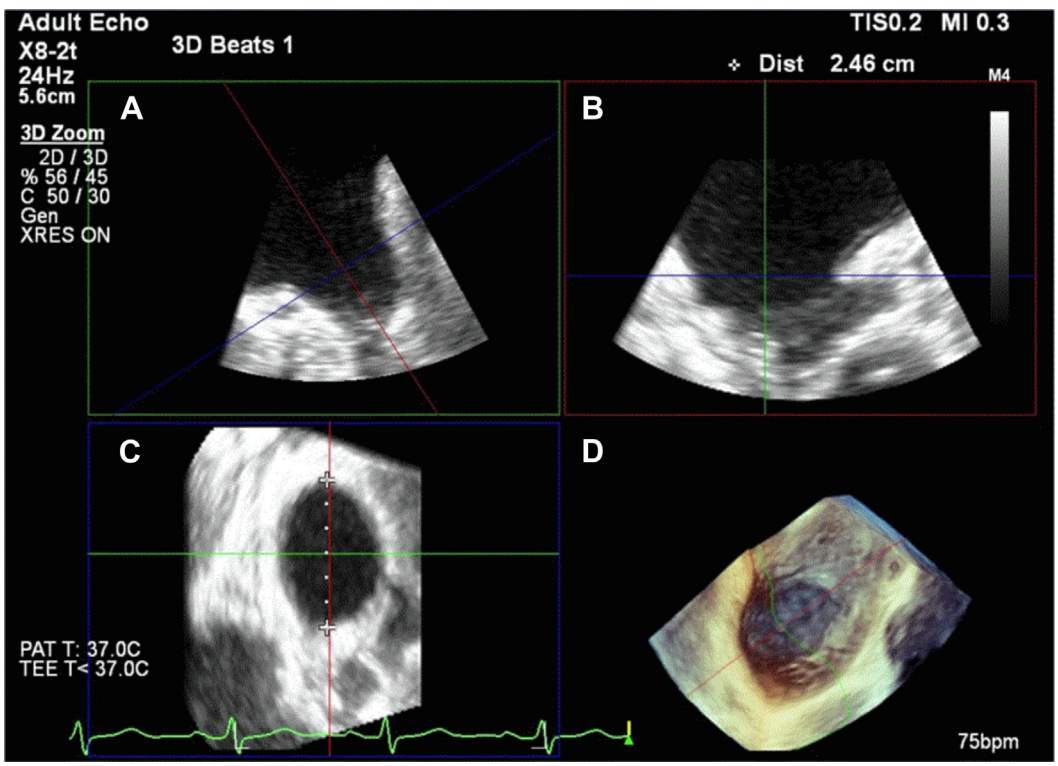
The differential diagnosis of this finding includes acute vs delayed device migration with risk of embolization.

INVESTIGATIONS

Gated cardiac computed tomography (CT) multiplanar reconstruction demonstrated a 23-mm-deep, chicken-wing LAA morphology with device migration into the proximal LA, with <10% of the distal device in contact with tissue (Figure 4). Complete contrast opacification of the LAA and the device demonstrated no device-related thrombus, and the uncompressed device diameter measured by CT suggested that a 27-mm—not a 31-mm—device was originally implanted (Figure 5).

After multidisciplinary discussions with the structural heart team, case planning for transcatheter device extraction began, using benchtop models to replicate and practice device extraction (Figure 6, Video 1). We selected the 24-F MitraClip steerable guide catheter (SGC) (Abbott Vascular) as the recapture sheath. To maintain hemostasis and allow multiple catheters for stabilization and capture, a 14-F sheath was "hubbed" inside the SGC (Figure 6). For device capture, a STERIS Raptor forceps was used to grasp the device while a gooseneck snare was used to control the device's waist. During benchtop extraction, we discovered grasping the device's recessed hub or periphery resulted in unsuccessful capture

FIGURE 1 Landing Zone Measurements



Intraoperative 3-dimensional transesophageal echocardiography of index device implantation, (A) seen at 45°, (B) seen at 135° showing an anterosuperior left atrial appendage (LAA) chicken wing morphology, (C) seen with en face view of the LAA ostium, and D) seen with 3-dimensional rendering of the LAA ostium.

(Videos 2 and 3). Rather, grasping immediately adjacent to the recessed hub allowed successful device capture into the SGC (Video 4).

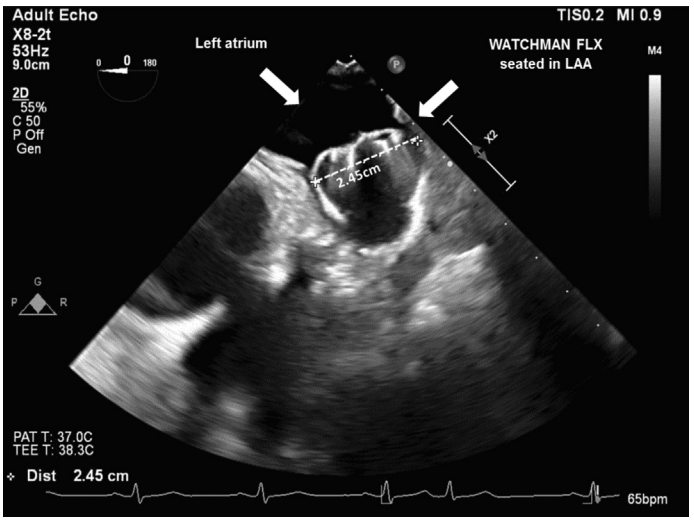
MANAGEMENT

The procedural was conducted under general anesthesia and with surgical support on standby (cardiothoracic surgeon and perfusion) in the hybrid operating room. After endotracheal intubation, a Sentinel carotid embolic protection (CEP) device (Boston Scientific) was deployed via the right radial artery into the right innominate and left common carotid artery. Next, TEE-guided transseptal puncture was performed in the inferior and mid-posterior position. After establishing an LA rail with a pigtail wire, the SGC was advanced across the interatrial septum. Ultimately the proximal hub of the SGC was loaded with a 14-F × 30 cm side-arm sheath (Cook Medical). Under 3D TEE guidance, the SGC was advanced to face the previously implanted occluder device, with steering performed by counterclockwise rotation of the SGC and applying a negative (-) knob to unflex the SGC. This maneuvering allowed the distal end of the SGC to point directly at the occluder device. Next, a 35-mm gooseneck snare was then advanced around the proximal portion of the migrated device (**Figure 7A**, Video 5) followed by the grasping device directed to the face of the device (**Figure 7B**). The migrated device was grasped at the intended site under 3D TEE and fluoroscopic guidance. Next, the SGC was advanced over the Raptor-device rail and tension was applied to the Raptor catheter as the SGC was advanced, capturing the migrated device and disengaging its anchors (Video 6). Once fully disengaged, the device was extracted into the SGC by retracting the Raptor catheter (Video 7). Immediate and delayed TEE confirmed no tissue injury or pericardial fluid accumulation. The SGC containing the recaptured device was removed, followed by recapture and removal of the CEP. The recaptured CEP showed evidence of embolized tissue debris, and final measurements of the extracted device confirmed a 27-mm Watchman FLX (**Figure 7C**). Femoral hemostasis was achieved with Perclose (Abbott Vascular), and radial artery hemostasis was achieved using TR Band (Terumo). The patient tolerated the procedure well without complications, successfully extubated immediately after, and discharged the next day on OAC.

DISCUSSION

LAAO device embolization is typically rare, occurring at a rate of 0.6% to 0.7% from the PROTECT-AF

FIGURE 2 Intraprocedural Post Implant Measurement

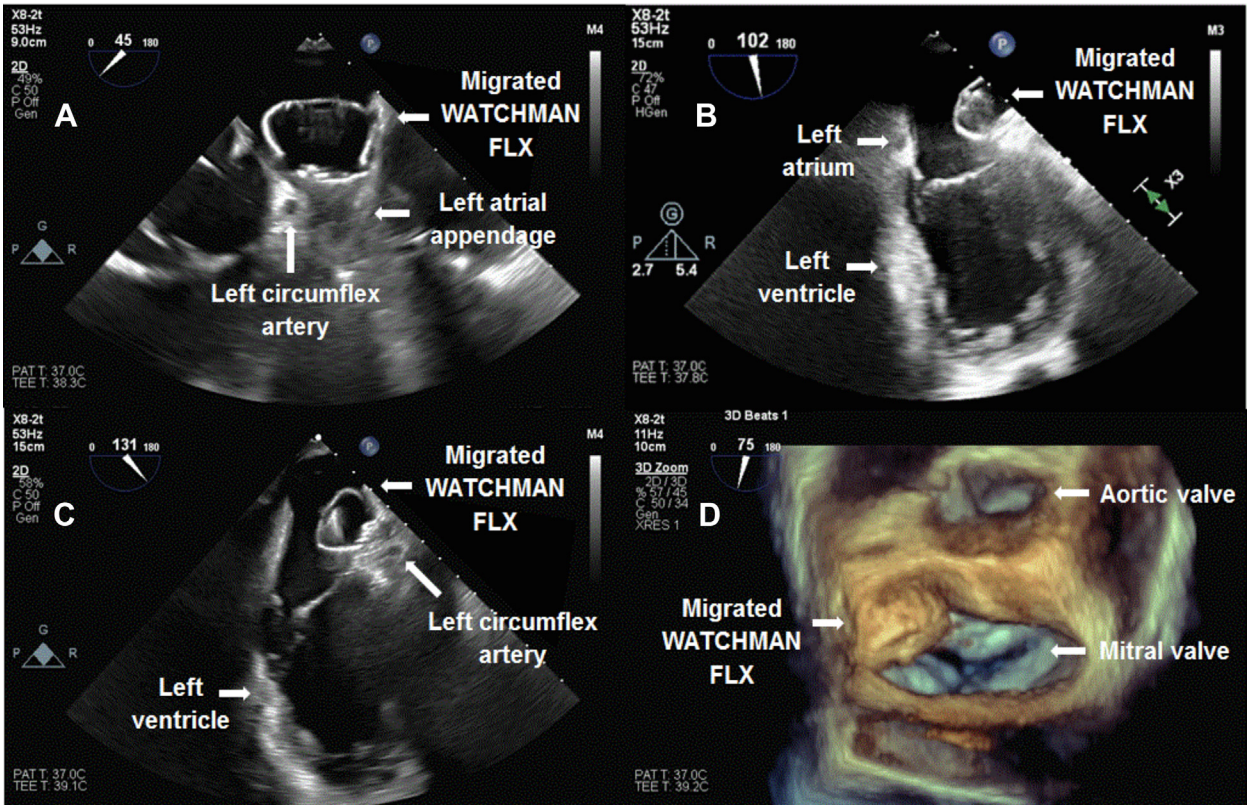


Postimplantation of reported 31-mm left atrial appendage occluder device.

(WATCHMAN Left Atrial Appendage System for Embolic PROTECTion in Patients With Atrial Fibrillation) and PREVAIL (Prospective Randomized Evaluation of the WATCHMAN LAA Closure Device in Patients With Atrial Fibrillation [AF] Versus Long Term Warfarin Therapy) trials, with 0.2% rate of embolization within 7 days of implantation.[1] The most common sites of device migration or embolization are the proximal LAA, LA, left ventricle, and aorta.[2] Embolization into the left ventricle risks papillary muscle rupture, damage to the aortomitral valve apparatus, and left ventricular outflow tract obstruction.[2] The exact timing of dislodgement from the LAA varies but tends to occur in the immediate to early postimplantation period, though case reports have found several late embolization occurring months after implantation.[3] The mechanisms behind device embolization include incorrect device sizing (the likely scenario in this case), challenging LAA anatomy usually with shallow depth, suboptimal delivery, unsuitable device characteristics, vigorous tug testing, and acute proximal migration after device release (ie, popcorn effect).[2,4] Other theorized mechanisms could be dynamic LA pressure (eg, from low to high) changes along with a hypercontractile LAA, which may result in proximal migration. In addition, most patients are typically asymptomatic when devices dislodge, although hemodynamic instability, arrhythmias, and cerebral infarction occur.[5]

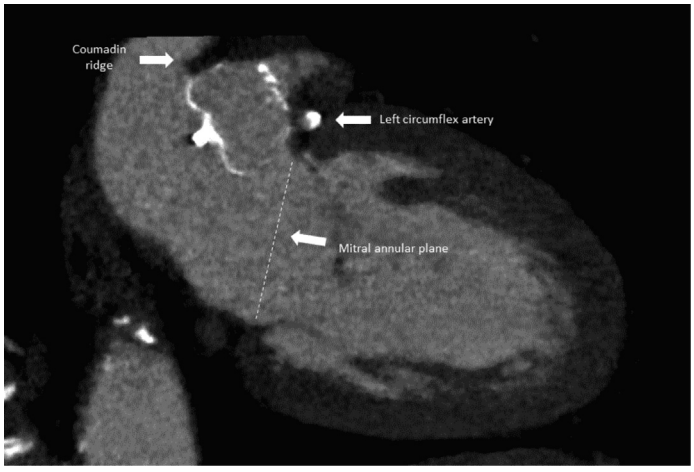
Surgical explantation of migrated or embolized LAAO devices and successful percutaneous snaring of

FIGURE 3 10-Week TEE Device Assessment



TEE demonstrating migrated left atrial appendage occluder device at (A) 45°, (B) 102°, (C) 135°, and (D) with 3-dimensional rendering. TEE = transesophageal echocardiography.

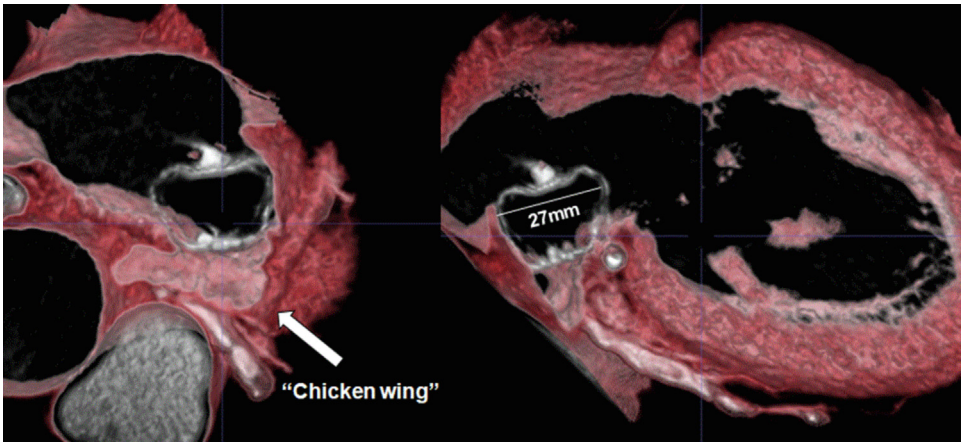
FIGURE 4 Cardiac Gated CT Assessment



Cardiac CT confirming a migrated device sitting above the left circumflex artery, with contrast seen in the left atrial appendage demonstrating patency. CT = computed tomography.

embolized LAAO devices have been previously described.[6-9] However, delayed percutaneous extraction of a migrated, endothelialized device that is still in contact with LAA tissue has not previously been described. For transcatheter extraction, preoperative imaging with cardiac CT and multiplanar reconstruction is essential in effective case planning and execution. Given risk of disruption of the LAA wall during extraction, the procedure should be planned in a hybrid operating room with the cardiothoracic surgery on standby. Depending on the location of device migration, a transseptal (with migration to LAA or LA) or retrograde (with migration to LV or aorta) approach may be considered. In this case, while CT did not demonstrate any superimposed thrombus or hypoattenuated thickening, the degree of endothelialization was unclear, which prompted our ultimate use of a CEP device. Given the safety profile of CEP, we would strongly advise use of CEP if extraction of such devices is performed. Large sheaths are preferred as the delivery/capture vessels, such as the 23-F Micra (Medtronic) or 14-F to 20-F

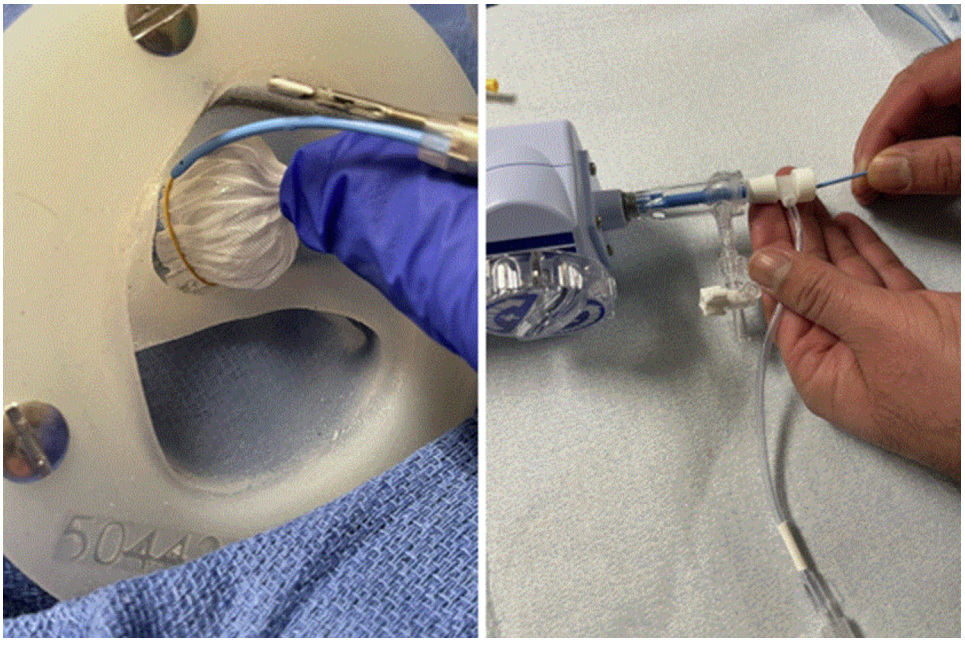
FIGURE 5 Cardiac-Gated CT Reconstruction



Cardiac CT 3-dimensional reconstruction with device diameter measurement. CT = computed tomography.

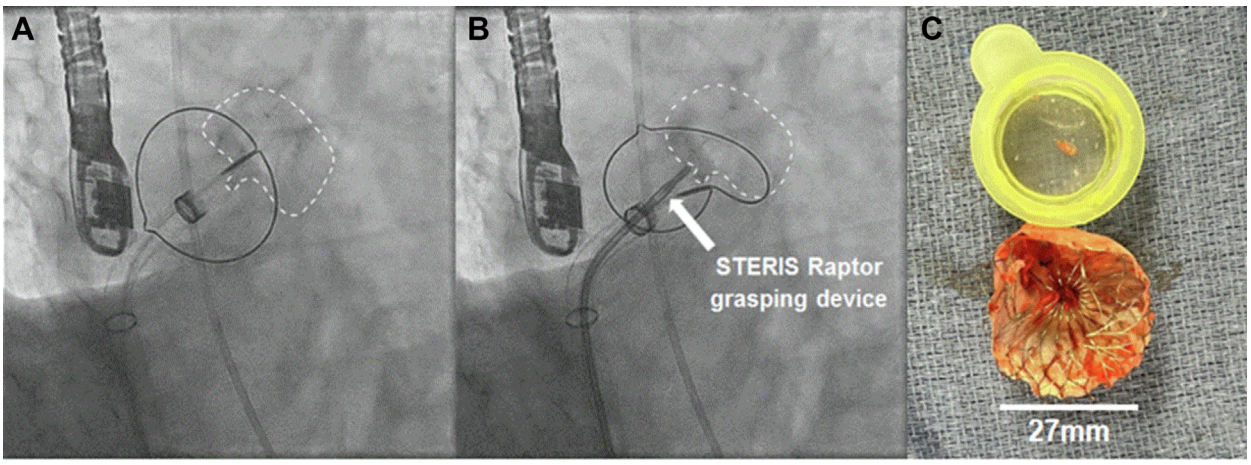
CheckFlo (Cook Medical) sheaths. This is the first published case report utilizing the MitraClip SGC (24-F), which we chose for its steerability and coaxial delivery to the face of the LAAO occluder device, and unlike the Medtronic Micra sheath, it is designed for use within the LA. Additionally, the SGC was chosen for this case because the braided Pebax polymer composition provided a stiff delivery system and strong distal orifice to allow for device capture. In the absence of a rigid and strong distal capture orifice, the implanted occluder device may not collapse and its anchors may not disengage, with significant risk of pericardial effusion or tamponade if there is trauma to the LAA or LA from these anchors. To maintain

FIGURE 6 Benchtop "Snare and Recapture" Technique



Benchtop practice model demonstrating "grasp-and-snare" extraction strategy, using a 14-F sheath within steerable guide catheter.

FIGURE 7 Procedural Snare and Recapture with Ultimate Extraction



(A) Snare directed at proximal portion of migrated device; (B) Raptor device directed toward migrated device; and (C) material captured by the carotid embolic protection (top) and extracted left atrial appendage occluder device (bottom).

integrity of the proximal hemostatic valve of the SGC, we hubbed a 14-F × 30 cm sidearm sheath. The hubbed 14-F sheath allows for simultaneous delivery of multiple devices (eg, Raptor and the gooseneck snare) without compromising the SGC hemostatic valve. In cases in which only the Raptor catheter is utilized, any 8-F off-the-shelf sheath can be used for delivery. Used in a variety of structural and peripheral interventions, snare devices are optional, but we believe they would help stabilize the device waist. Furthermore, should recapture be unsuccessful and the device embolize, the snare may afford immediate stabilization while alternate methods of recapture or conversion to surgery are considered. The STERIS Raptor, borrowed from gastrointestinal interventions, has a grasping diameter of approximately 2.5 cm when fully opened and has multiple serrated elements to provide better grasping once captured. Despite the technology and operator experience, percutaneous device extraction remains a high-risk procedure, especially for a delayed migrated device.

With the device fully and safely extracted, the decision to proceed with LAAO via alternate means should be considered on a case-by-case basis. Reattempting LAAO at the time of extraction vs staging to separate the risks associated with each procedure should be considered. The specific mechanism(s) contributing to device migration should be understood before reattempting percutaneous closure. In the United States, there are only 2 commercially available devices, so reattempting LAAO with a larger device or with the alternate device based on depth and ostial dimensions remains a consideration. Alternatively, there are several other percutaneous systems that are currently investigational and could be considered should the patient meet clinical and anatomic inclusion criteria after recovery from device extraction. In those in whom percutaneous extraction is not feasible/available, surgical extraction with surgical exclusion remains an available option.[9]

FOLLOW-UP

On 30-day clinical follow-up, the patient had returned to work but under permanent modified desk duty. He was offered an LAAO with an alternate commercial and/or clinical trial device. Given the relative traumatic experience following the index implantation, the patient and his family declined any further LAAO implantation opting for chronic OAC.

CONCLUSIONS

Percutaneous device extraction of a migrated LAAO is a high-risk but feasible procedure. We present a clinical case in which careful planning with cardiac

CT and benchtop practice models was essential for successful extraction. In addition, the importance of CEP was shown, as we captured large embolized tissue debris. Last, to our knowledge, this is the first transcatheter Watchman FLX extraction using a MitraClip SGC as the capture vessel.

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Dr Wong has reported that he has no relationships relevant to the contents of this paper to disclose. Dr Aman has served as a consultant for Abbott Structural Heart, Siemens, Phillips, and ReValve Solutions. Dr Kiaii has served as a consultant for Abbott, Johnson and Johnson, Medtronic, and Corcym. Dr Rogers has served as a consultant for Abbott Structural Heart, Boston Scientific, and Siemens Healthcare. Dr Singh has served as a consultant and/or on the advisory board for Abbott Structural Heart, Boston Scientific, Siemens Healthcare, and Phillips.

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KEY WORDS atrial fibrillation, computed tomography, echocardiography, occluder, 3-dimensional imaging

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