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CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CLINICAL CASE SERIES

Retrieval Strategies for Embolized Left Atrial Appendage Closure Devices

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ABSTRACT

BACKGROUND Device embolization (DE) is a rare but potentially life-threatening complication of left atrial appendage occlusion (LAAO). As landmark trials broaden the eligible population for LAAO, operator preparedness for DE management becomes increasingly critical.

CASE SUMMARY We present 4 cases of LAAO DE managed with distinct retrieval strategies: 1) open surgical retrieval with concurrent AtriClip ligation for an endothelialized left atrial device; 2) sequential transseptal then retrograde arterial snaring for intraprocedural migration to the abdominal aorta; 3) transseptal retrieval using a dedicated ONO system with cerebral embolic protection for partial left atrial dislodgment; and 4) retrograde large-bore arterial retrieval for delayed aortic embolization.

CONCLUSIONS Percutaneous retrieval is feasible in most cases when tailored to embolization location. Surgical backup remains indispensable. Prevention requires rigorous preprocedural imaging, accurate sizing, and routine post-implant surveillance.

TAKE HOME MESSAGE LAAO embolization has high mortality, accurate device sizing as well as follow up imaging in paramount. (JACC Case Rep. 2026;31:109537) © 2026 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/).

Percutaneous left atrial appendage occlusion (LAAO) is an established stroke-prevention strategy for patients with nonvalvular atrial fibrillation (AF) who cannot tolerate long-term anticoagulation. Pivotal randomized trials have demonstrated noninferiority of LAAO vs warfarin for the composite endpoint of stroke, systemic embolism, and cardiovascular death.[1,2] Iterative device design has substantially reduced procedural risk:

TAKE-HOME MESSAGES

- Device embolization carries high mortality, particularly after a failed initial retrieval attempt.
- Accurate device sizing with imaging as well as follow-up TEE are essential.
- Surgical backup is paramount when anatomy precludes safe percutaneous retrieval.

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ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation

LA = left atrium

LAA = left atrial appendage

LAAO = left atrial appendage occlusion

TEE = transesophageal echocardiography

the second-generation Watchman Flx device reported zero device embolization events at 2 years in its pivotal trial,[3] a finding replicated in a subsequent analysis of more than 97,000 real-world procedures, in which the device embolization rate was 0.04% at 45 days.[4] A separate randomized comparison of the dual disc-and-lobe Amulet device against Watchman established noninferiority but reported a numerically higher embolization rate with Amulet (0.7% vs 0.2%).[5]

The evidence base for LAAO is evolving rapidly. A large randomized trial comparing LAAO directly to non-vitamin K antagonist oral anticoagulants in anticoagulation-eligible patients recently demonstrated noninferiority for cardiovascular death, stroke, and systemic embolism, with superior reduction in nonprocedural bleeding (10.9% vs 19.0%, $P < 0.001$).[6] Conversely, a separate trial found that LAAO failed noninferiority vs optimized medical therapy in very high-risk patients (HAS-BLED >3), reinforcing the primacy of patient selection.[7] As LAAO adoption grows, the absolute number of complications requiring management will grow correspondingly.

Despite its low incidence, device embolization carries substantial morbidity and mortality. A multicenter registry reported 10.2% overall mortality following embolization, rising to 24.1% when a second retrieval attempt was required.[8] Optimal management depends on embolization location, timing, and anatomy, and no single retrieval strategy is universally applicable. We present 4 cases illustrating distinct retrieval approaches, with the goal of providing a practical, location-guided decision framework for operators.

CASES

CASE 1: SURGICAL RETRIEVAL WITH CONCURRENT LAA LIGATION. A 74-year-old woman with paroxysmal AF (CHA_2DS_2-VASc 6, HAS-BLED 4) underwent 20-mm Amulet implantation for recurrent oral bleeding (Figure 1). Follow-up transesophageal echocardiography (TEE) revealed device dislodgment along the posterior left atrial appendage (LAA) border with free flow into the ostium, with partial device endothelialization apparent on 3-dimensional reconstruction (Figure 2). Given early endothelialization and proximity to the mitral valve,

VISUAL SUMMARY **Location-Guided Retrieval Strategy for Embolized LAAO Devices**

Case	Embolization Site	Retrieval Strategy	Access	Outcome
1	Left atrium (posterior LAA border, partially endothelialized)	Open surgical retrieval + AtriClip LAA ligation	Median sternotomy, cardiopulmonary bypass	Aspirin monotherapy; event-free at 1 year
2	Left atrium → left ventricle → abdominal aorta (intra-procedural)	Sequential transseptal snare → retrograde arterial snare	26 Fr transseptal sheath; 16 Fr arterial sheath	LAA closure abandoned; event-free at 18 months
3	Left atrium (partial dislodgment, 90° rotation, peri-device leak)	ONO retrieval system + Raptor grasper; cerebral embolic protection	Transseptal access; radial artery (CEP)	Percutaneous retrieval; event-free at 18 months
4	Distal ascending aorta (asymptomatic, no fracture or dissection)	Gooseneck snare → ONO retrieval basket	18 Fr DrySeal sheath, retrograde arterial	Percutaneous retrieval; event-free at 24 months

Tabular summary comparing embolization site, retrieval strategy, vascular access, and clinical outcome across all 4 cases, illustrating that retrieval approach is determined primarily by embolization location. CEP = cerebral embolic protection; LAA = left atrial appendage; LAAO = left atrial appendage occlusion.

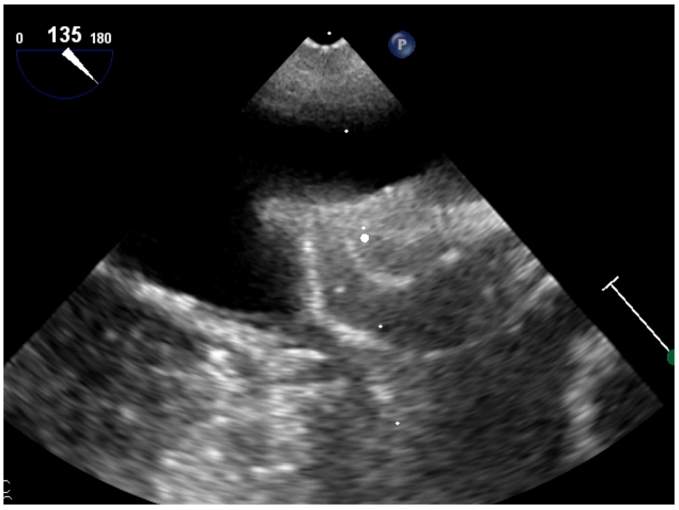
percutaneous retrieval was considered unsafe after multidisciplinary discussion. Via median sternotomy and cardiopulmonary bypass, the device was surgically excised along the endothelialized border and the LAA ligated at its base using an AtriClip (AtriCure). She was discharged on aspirin monotherapy and remained event-free at 1 year.

CASE 2: SEQUENTIAL TRANSSEPTAL AND RETROGRADE ARTERIAL RETRIEVAL. A 77-year-old man with permanent AF, previous surgical LAA amputation, and a bioprosthetic aortic valve (CHA_2DS_2-VASc 4, HAS-BLED 4) underwent 16-mm Amulet implantation into a 1-cm residual LAA stump (**Figure 3**). During unsheathing, the device detached and mobilized into the left atrium (LA). Transseptal snaring via a 26-F MitraClip sheath dislodged the device into the left ventricle and subsequently into the abdominal aorta. Rapid left femoral arterial access was obtained, and the device was successfully retrieved via a 16-F Cook sheath using an EN Snare (Merit Medical) (**Figure 4**). Further LAA closure was abandoned. The patient remained event-free on anticoagulation at 18 months.

CASE 3: TRANSSEPTAL RETRIEVAL WITH CEREBRAL EMBOLIC PROTECTION. A 70-year-old man with persistent AF (CHA_2DS_2-VASc 3, HAS-BLED 2) underwent concomitant pulmonary vein isolation and 35-mm Watchman Flx implantation guided by intracardiac echocardiography. Follow-up TEE revealed partial dislodgment with 90° counterclockwise rotation and a peri-device leak on color Doppler (**Figure 5**). A Sentinel cerebral embolic protection device was deployed via right radial access before transseptal re-entry. Using a VersaCross transseptal system, the Watchman Flx was engaged with an ONO retrieval device (ONOCOR) combined with a Raptor grasping catheter (**Figure 6**), collapsed into the retrieval sheath, and extracted. The patient was discharged on apixaban and aspirin, event-free at 18 months.

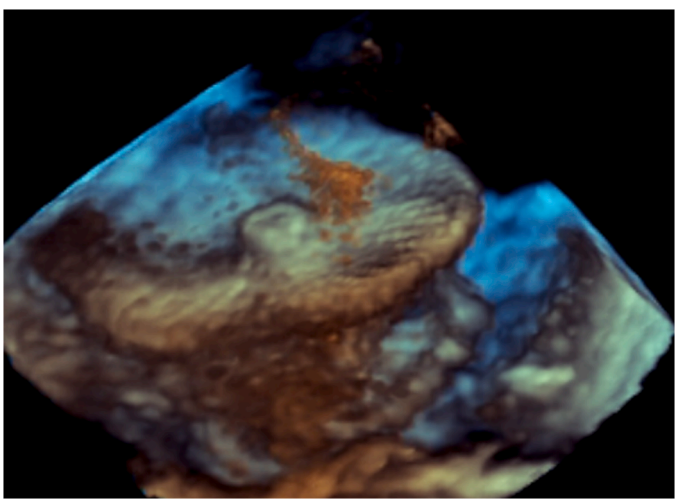
CASE 4: RETROGRADE AORTIC RETRIEVAL OF A DELAYED-EMBOLIZED DEVICE. A 71-year-old man with paroxysmal AF (CHA_2DS_2-VASc 2, HAS-BLED 2) underwent 25-mm Amulet implantation with secure immediate postprocedural imaging. Follow-up TEE revealed asymptomatic embolization to the distal ascending aorta without fracture, thrombus, or dissection, confirmed on chest radiography (**Figure 7**) and fluoroscopy (**Figure 8**). An 18-F DrySeal sheath (Gore Medical) was placed via the right femoral

FIGURE 1 Amulet Device Outside the Left Atrial Appendage



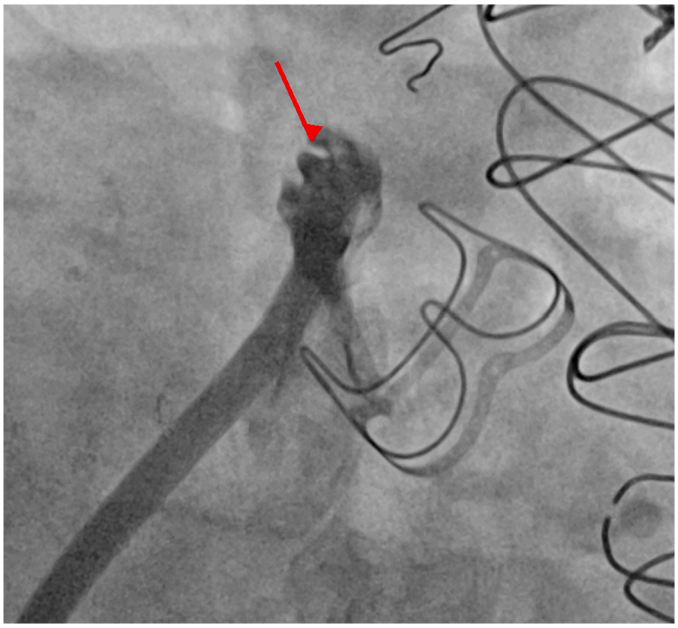
Transesophageal echocardiography demonstrating the 20-mm Amulet device displaced from its intended position within the left atrial appendage, with the device body visible in the left atrial cavity.

FIGURE 2 3-Dimensional Reconstruction of the Partially Endothelialized Amulet Device



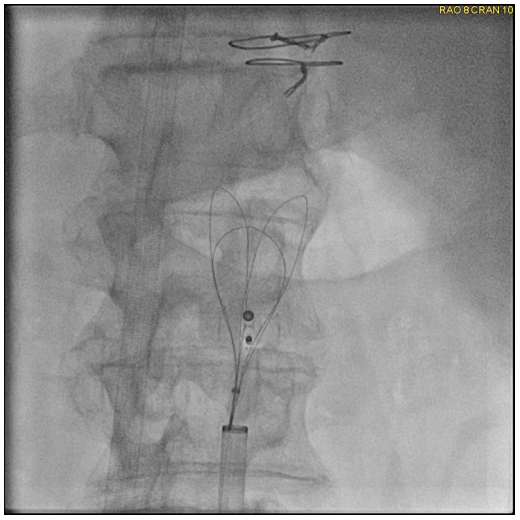
En face 3-dimensional transesophageal echocardiographic reconstruction showing the dislodged Amulet device with overlying tissue ingrowth (orange) along its proximal disc, consistent with partial endothelialization.

FIGURE 3 Fluoroscopic Image of the Residual Left Atrial Appendage Stump



Fluoroscopy demonstrating catheter manipulation within the small residual left atrial appendage stump following previous surgical amputation (arrow), illustrating the anatomically constrained landing zone encountered during device implantation.

FIGURE 4 Snare Capture of the Embolized Amulet Device in the Aorta



Fluoroscopic image showing an EN Snare engaging the embolized Amulet device after its migration into the abdominal aorta, immediately before percutaneous retrieval

artery. An ONO retrieval device advanced through a 14-F double-curved sheath failed initial capture attempts; a 3-cm gooseneck snare via a 7-F internal mammary artery guide catheter successfully engaged one device lobe and delivered it into the ONO basket (Figure 9). The assembly was withdrawn en masse through the DrySeal sheath. Postprocedural TEE confirmed no aortic injury. The patient was discharged on apixaban, event-free at 24 months.

DISCUSSION

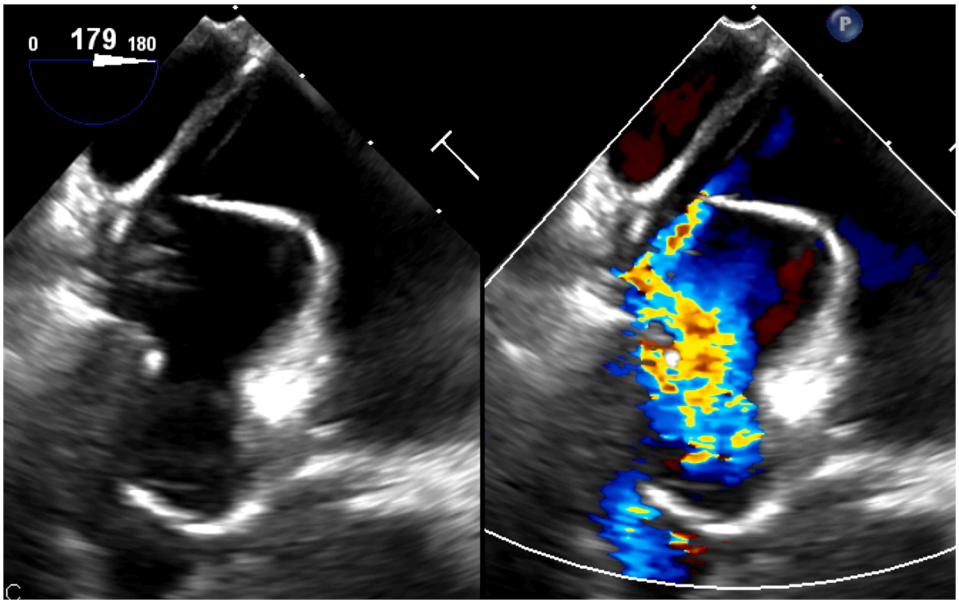
This 4-case series illustrates the heterogeneity of LAAO device embolization in anatomical location, timing, and clinical complexity. Each case required individualized decision-making based on device location, valvular or vascular involvement, and available institutional resources. No single retrieval strategy is universally applicable.

EVOLVING CONTEXT: EXPANDING LAAO UTILIZATION. As discussed previously, recent trials establish LAAO noninferiority vs non-vitamin K antagonist oral anticoagulants while also reinforcing the importance of patient selection in very high-risk subgroups.[6,7] As adoption grows and indications expand, the absolute burden of device embolization will increase, making operator preparedness for retrieval a clinical imperative.

INCIDENCE AND CONSEQUENCES OF DEVICE EMBOLIZATION. Device embolization rates have declined with second-generation devices, yet consequences remain severe. A large registry of 120,278 Watchman procedures reported 14% in-hospital mortality, with nearly half of events occurring post discharge.[9] A separate registry found mortality rose from 2.9% after a first retrieval attempt to 24.1% after a second ($P < 0.001$).[8] Late detection (>1 week) is associated with distal migration and near-universal surgical requirement,[10] underscoring that the initial strategy must be optimized and that surveillance imaging is non-negotiable. Table 1 lists major studies and the incidence of DE.

LOCATION-GUIDED RETRIEVAL STRATEGY. Embolization location is the primary determinant of retrieval access. Please refer to table 2 for case summary. LA-confined devices (cases 1 and 3) are approached transseptally; adherence or mitral proximity may mandate primary surgery, as in case 1. Left ventricular embolization (case 2) carries the highest risk due to valvular entanglement; both transseptal and retrograde arterial routes are described, with surgical escalation reserved for instability or mechanical trapping. Aortic embolization (cases 2 and 4)

FIGURE 5 Transesophageal Echocardiography of the Partially Dislodged Watchman Flx Device



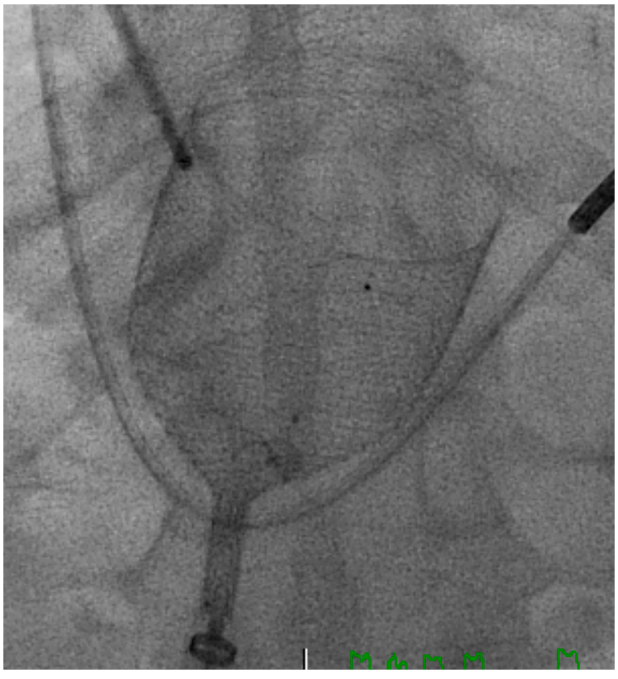
2-dimensional (left) and color Doppler (right) transesophageal echocardiography demonstrating partial dislodgment of the Watchman Flx device with rotation and a peri-device leak, identified by turbulent flow on color Doppler.

requires retrograde large-bore arterial access (≥14 F) with snare capture into a structured basket.

The ONO dedicated retrieval system, used in cases 3 and 4, provides controlled extraction superior to unguided snaring, constraining the device during collapse and reducing aortic wall injury risk. Multiple snare geometries may be needed before adequate capture is achieved, as in case 4, and dual venous-arterial access established at the outset enables rapid strategic pivoting if a device migrates during retrieval. Cerebral embolic protection, deployed via radial access in case 3, is rationally indicated when device manipulation near the LA or aortic arch risks cerebral embolization and is increasingly described in contemporary retrieval series.[8]

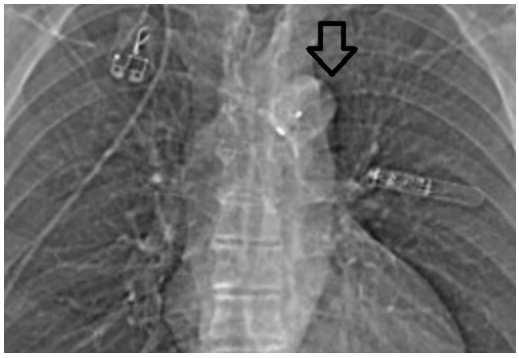
ROLE OF MINIMALLY INVASIVE SURGERY IN CASE 1. Whether minimally invasive surgery could have been used in case 1 merits comment. Thoracoscopic epicardial clip placement (eg, AtriClip) without sternotomy is established for de novo LAA exclusion, with low long-term thromboembolic rates.[11] However, this technique provides epicardial access only and cannot accommodate dissection of a device already adherent to endocardial tissue, particularly given proximity to the mitral apparatus. A thoracoscopic approach was therefore not feasible, and median sternotomy with cardiopulmonary bypass

FIGURE 6 ONO Retrieval Device Engaging the Dislodged Watchman Flx



Fluoroscopic image showing the ONO retrieval basket deployed around the partially dislodged Watchman Flx device during percutaneous transseptal extraction.

FIGURE 7 Chest Radiograph Showing the Embolized Amulet Device in the Ascending Aorta

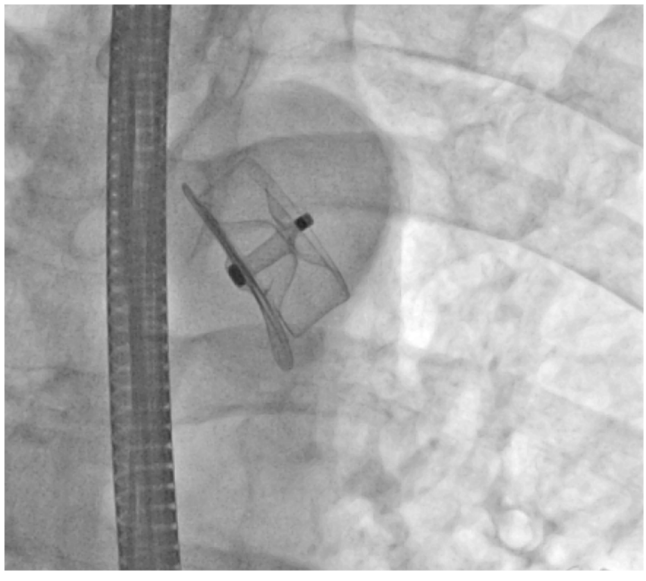


Posteroanterior chest radiograph with the embolized Amulet device (arrow) visualized as a radiopaque structure overlying the mediastinum, confirming its position in the ascending aorta

was required for direct intracardiac visualization and safe extraction.

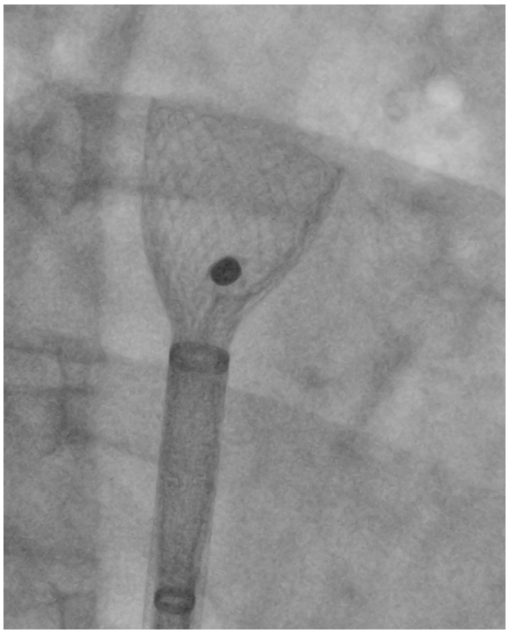
PREVENTION. Device-appendage size mismatch, particularly undersizing, is the most consistently identified risk factor for embolization.[9,10] Preprocedural TEE or computed tomography with 3-dimensional reconstruction is essential for accurate landing-zone measurement and device selection.[12] Intraprocedural confirmation of position, anchoring, sizing, and seal before release is mandatory.[13] Routine surveillance at discharge and 45 to 90 days post implantation enables detection while percutaneous retrieval remains feasible. The residual stump anatomy in case 2 illustrates that some configurations may not be suitable for percutaneous closure; multidisciplinary risk-benefit assessment is advisable.

FIGURE 8 Fluoroscopic Image of the Amulet Device Lodged in the Ascending Aorta



Fluoroscopy demonstrating the disc-and-lobe structure of the embolized Amulet device, with its radiopaque markers visible, lodged within the ascending aorta before retrieval.

FIGURE 9 ONO Basket Capturing the Embolized Amulet Device



Fluoroscopic image showing the ONO retrieval basket engaging the radiopaque marker of the embolized Amulet device within the aorta during the final stage of percutaneous retrieval.

STUDY LIMITATIONS. This is a single-center, 4-case series subject to selection bias and limited generalizability. Conclusions regarding retrieval strategy superiority cannot be drawn; all decisions were individualized to patient anatomy and institutional expertise.

AI DISCLOSURE Artificial intelligence language tools were used to assist in manuscript preparation. All clinical content, data interpretation, and final text were reviewed and approved by the authors.

TABLE 1 Major Trials and Registries Informing Left Atrial Appendage Occlusion Efficacy and Device Embolization Management

Study (Year)	Design/No. of Patients	Device	DE Rate	Primary Retrieval	Key Outcomes
PROTECT AF (2009)	RCT; n = 463	Watchman 1st gen	0.6%	Surgical or percutaneous	Noninferior to warfarin for stroke/SE/CV death; lower hemorrhagic stroke
PREVAIL (2014)	RCT; n = 269	Watchman 1st gen	0.7%	Surgical or percutaneous	Noninferiority for early safety met; long-term stroke reduction confirmed
Amulet IDE (2021)	RCT; n = 1,878	Amulet vs Watchman	Amulet 0.7% vs Watchman 0.2%	Percutaneous-first; surgical backup	Noninferior for safety/effectiveness; Amulet had higher DE rate
PINNACLE FLX (2021/2023)	Single-arm; n = 400	Watchman FLX	0% at 2 y	N/A	2-y stroke/SE 3.4%; 100% anatomic closure at 1 y; DE engineered out via dual-row anchors
SURPASS/NCDR (2024)	Registry; n = 97,185	Watchman FLX (real-world)	0.04% at 45 d	Per center protocol	Mirrors PINNACLE FLX in real-world use; high-volume centers had lowest complications
CHAMPION-AF (2026)	RCT; n = 3,000	Watchman FLX vs NOAC	Not DE-focused	N/A	First head-to-head vs NOAC; noninferior for CV death/stroke/SE; superior nonprocedural bleeding (10.9% vs 19.0%)
CLOSURE-AF (2025)	RCT; n = 912	Watchman/Amulet vs medical therapy	Not DE-focused	N/A	Failed noninferiority in very high-risk patients (HAS-BLED >3); reinforces patient selection
NCDR DME Analysis (2023)	Registry; n = 120,278	Watchman (both gens)	In-hospital 0.07%	Surgical in ~46% of in-hospital events	In-hospital mortality 14%; nearly half of events occurred post discharge
LAAODE (2021)	Systematic review; n = 103	Watchman + Amulet/ACP	~2% (est.)	Surgical in 100% of events >1 wk	33% mortality in late (>1 wk) events
Eppinger et al. (2024)	Registry; n = 108 DE events	Watchman + Amulet	Consecutive events	Percutaneous 75%; surgical 21.3%	Mortality 10.2%; mortality after 2nd attempt 24.1% vs 2.9% after 1st ($P < 0.001$)

ACP = Amplatzer Cardiac Plug; CV = cardiovascular; DE = device embolization; NCDR = National Cardiovascular Data Registry; NOAC = non-vitamin K antagonist oral anticoagulant; N/A = not applicable; RCT = randomized controlled trial; SE = systemic embolism.

TABLE 2 Case Summary: Patient Characteristics, Embolization Features, and Retrieval Strategies

Case	Age, y/Sex	Device (Size)	Embolization Location	Timing of Detection	Retrieval Strategy	Outcome at Follow-Up
1	74F	Amulet 20 mm	Left atrium (posterior LAA border; partially endothelialized)	45-d TEE	Surgical retrieval + AtriClip LAA ligation via median sternotomy (CPB)	Aspirin monotherapy at discharge; event-free at 1 y
2	77M	Amulet 16 mm	LA → LV → abdominal aorta (intraprocedural migration)	Intraprocedural	Sequential: transseptal EN Snare → retrograde arterial EN Snare via 16 F Cook sheath	LAA closure abandoned; continued DOAC + aspirin; event-free at 18 mo
3	70M	Watchman FLX 35 mm	Partial LA dislodgment: 90° rotation, 2.7 mm peri-device leak	45-d TEE	Transseptal: ONO retrieval system + Raptor grasper; Sentinel CEP via right radial access	Successful percutaneous retrieval; apixaban + aspirin; event-free at 18 mo
4	71M	Amulet 25 mm	Distal ascending aorta (asymptomatic, no fracture or dissection)	45-d TEE	Retrograde arterial: 18 F DrySeal sheath; gooseneck snare via 7 F IMA guide → ONO basket via 14 F double-curved sheath	Successful percutaneous retrieval; apixaban; event-free at 24 mo

CEP = cerebral embolic protection; CPB = cardiopulmonary bypass; DOAC = direct oral anticoagulant; IMA= internal mammary artery; LA = left atrium; LAA = left atrial appendage; LV = left ventricle; TEE = transesophageal echocardiography.

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KEY WORDS atrial fibrillation, device embolization, left atrial appendage occlusion, percutaneous retrieval, snare technique, structural heart disease