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Retrieval of embolised left atrial appendage closure devices

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Introduction

Device embolisation is a complication after left atrial appendage closure (LAAC) and may occur in up to 0.24% cases[1,2]. The Munich consensus document defines the need for repeated catheterisation in case of embolisation as a major device embolisation, while a successful retrieval in the same procedure is considered a minor embolisation[3]. However, information on retrieval strategies for embolised LAAC devices is scarce.

Methods

PATIENT COHORT

The Cardioangiologisches Centrum Bethanien (CCB) Frankfurt database was used to identify patients with LAAC device embolisations and retrieval attempts between April 2010 and October 2019.

DEVICE RETRIEVAL

Percutaneous LAAC retrieval was performed by experienced cardiologists.

All procedures were executed taking account of guidelines such as the Munich consensus document[3].

Results

MINOR AND MAJOR EMBOLISATION

A total of 711 devices were implanted **(Table 1)**. Total minor embolisation was 0.7% (n=5) and total major embolisation 0.8% (n=6). Major embolisation included WATCHMAN™ (n=2) (Boston Scientific, Marlborough, MA, USA), AMPLATZER™ Cardiac Plug (ACP) (n=2) (Abbott Vascular, Santa Clara, CA, USA), AMPLATZER™ Amulet™ (n=1) (Abbott Vascular) and LAmbre™ (n=1) (Lifetech Scientific, Shenzhen, China). Two additional cases were referred by external hospitals (WATCHMAN, n=1; Amulet, n=1).

Table 1. Devices implanted: total devices implanted and embolisations.

Device implanted	Minor embolisation	Major embolisation	Total number of implants
WATCHMAN	0% (0/209)	1% (2/209)	29% (209/711)
WATCHMAN FLX	0% (0/45)	0% (0/45)	6% (45/711)
AMPLATZER Vascular Plug	0% (0/2)	0% (0/2)	0.3% (2/711)
AMPLATZER Cardiac Plug	1% (1/101)	2% (2/101)	14% (101/711)
AMPLATZER Amulet	0.8% (2/241)	0.4% (1/241)	34% (241/711)
Coherex WaveCrest	4.7% (2/43)	0% (0/43)	6% (43/711)
LAmbre	0% (0/105)	0.9% (1/105)	15% (105/711)
Cardia Ultraseal	0% (0/5)	0% (0/5)	0.7% (5/711)
Total	0.7% (5/711)	0.8% (6/711)	
Numbers rounded up.			

TRANSSEPTAL RETRIEVAL FROM THE LEFT ATRIUM (n=6)

Transseptal retrieval of LAAC devices from the left atrium (LA) was attempted in six patients (ACP, n=2; AMPLATZER Amulet, n=3; Coherex WaveCrest® [Biosense Webster, Inc., Diamond Bar, CA, USA], n=1). While in four cases the embolisation was seen during implantation, in one patient it was discovered 47 days post implantation.

After transseptal puncture, a steerable sheath (MitraClip® delivery sheath [Abbott Vascular], 21 Fr inner diameter [ID], n=1; WaveCrest® delivery sheath, 17 Fr, n=1; and Cryoflex™, 12 Fr

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ID [FlexCath Advance™; Medtronic, Minneapolis, MN, USA], n=4) was placed in the LA. Procedural details are shown in **Supplementary Table 1**.

In four cases (ACP/Amulet; n=3, Coherex WaveCrest; n=1), the device was dislocated into the LA. For fixation, a 30 mm gooseneck snare was used to grab the occluder. For ACP/Amulet retrieval, a second 15 mm gooseneck snare was advanced to grab the central screw **(Figure 1, Moving image 1)**. The Coherex WaveCrest occluder could only be partially retracted into the sheath. Subsequently, it was pulled through the interatrial septum **(Figure 2)**.

In one case, Amulet fixation failed and the device embolised into the aorta. After arterial access, the occluder was pulled into the 12 Fr sheath by a gooseneck snare.

In one patient a first-generation Amulet device could not be retracted into the sheath. The device was then retracted through the interatrial septum and removed by snaring.

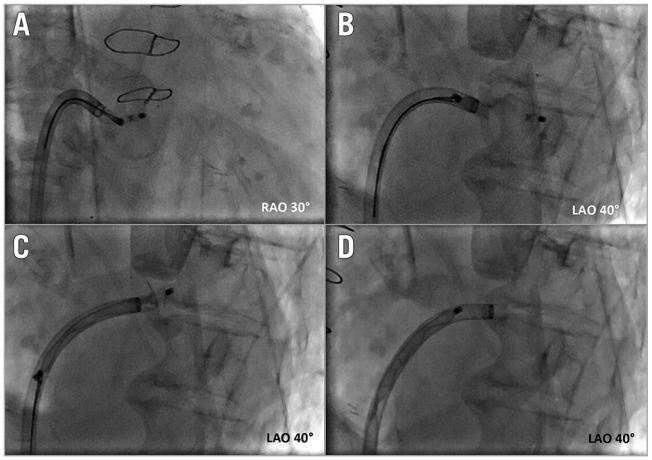

Figure 1. *Transseptal retrieval of an ACP from the LA via a steerable sheath. A) The disc's screw is snared to the IAS. B) - D) Stepwise complete retraction of the disc and the lobe into the sheath.*

One Amulet was partially dislodged in the LAA. Despite extensive manipulation using gooseneck snares and bioptomes, the device could not be retracted into the sheath. The procedure was abandoned and oral anticoagulation (OAC) continued.

TRANSARTERIAL RETRIEVAL FROM THE AORTA (n=5)

In four patients device retrieval from the aorta was attempted (Amulet 22 mm, n=1; WATCHMAN [21 and 24 mm], n=2; Coherex WaveCrest 27 mm, n=1; LAmbre 36/40 mm, n=1) using fluoroscopy via arterial access.

For Amulet retrieval, the central screw was snared and the device retracted. WATCHMAN occluders were retrieved by pulling the devices with a gooseneck snare or vascular forceps **(Supplementary Figure 1)**.

In one patient, a complex Coherex WaveCrest device retrieval from the descending aorta **(Supplementary Figure 2, Moving image 2)** was performed. Failed retraction into a 12 Fr sheath using a gooseneck snare led to dislodgement to the iliac bifurcation.

From the left femoral artery (16 Fr), the central hub of the device was wired, and the wire snared from the right femoral access sheath. Then, a balloon was advanced over the wire from the right femoral artery (12 Fr) to push the occluder while simultaneously pulling the device with retrieval forceps from the left.

Similarly, one embolised LAmbre device could not be retrieved by gooseneck snare **(Supplementary Figure 3, Moving image 3)**. Bilateral arterial access was gained, and the device was retrieved by a push and pull manoeuvre.

RETRIEVAL FROM THE LEFT VENTRICLE (n=2)

In two patients (Amulet, n=1; WATCHMAN, n=1) the device embolised to the left ventricle one day post implantation.

After transseptal access via a 12 Fr steerable sheath, extensive manipulation was performed using a steerable electrophysiology (EP) catheter and snaring, but retrieval failed. Consequently, the patient became haemodynamically unstable due to acute mitral regurgitation.

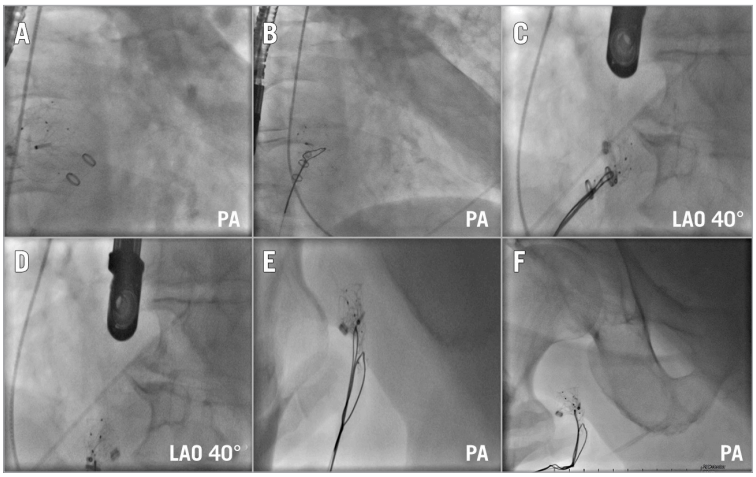

Figure 2. *Transseptal retrieval of a Coherex WaveCrest device from the LA. A) Anterior-posterior (PA) projection of an occluder in the LA. B) Fixation through the 17 Fr delivery sheath with a 30 mm gooseneck snare. C) Unsuccessful re-sheathing. Therefore, retraction of the fixed device and sheath through the IAS (D), the right atrium (E), and through the femoral vein (F).*

The patient was transferred to emergency heart surgery. After successful device explant and mitral valve repair, the patient went into acute right heart failure and died three weeks after the procedure.

The second patient with left ventricular (LV) embolisation was referred directly to successful surgical salvage.

Discussion

Despite the small number of patients, it appears feasible and safe to attempt percutaneous retrieval for devices embolised to the LA or aorta; however, surgery may be favoured for devices in the LV.

The AMULET registry reported a major device embolisation rate of 0.2%, while in EWOLUTION and in the post-approval WATCHMAN experience embolisation rates were reported as 0.2% and 0.24%, respectively[1,2,4]. This single centre reports a major embolisation rate of 0.8%. This included early market experience and one first-generation Amulet. Additionally, an unexpectedly high embolisation rate of the Coherex WaveCrest occluder of 4.7% was observed.

In contrast to a recent meta-analysis of case reports[5], we discovered device embolisation within 24 hours after implant in 12/13 cases. This underscores the recommendation for adequate imaging before discharge. Moreover, the same meta-analysis revealed embolisation to the LV as the most common location in 43%[5] in contrast to our data where the LV was the least common location (15%). This may be due to possible reporting bias in case reports.

For successful percutaneous retrieval, a large bore sheath (12-16 Fr) should be used to allow complete re-sheathing of the device. In the LA, steerable sheaths are helpful to improve manoeuvrability. Device fixation tools include gooseneck snares and bioptome forceps. Re-sheathing of some device types is difficult and successful retrieval warrants complex strategies. Interventional device retrieval from the LV is discouraged if device interaction with the mitral apparatus is present.

Limitations

This report is observational and retrieval approaches were left to the cardiologist's discretion. Additionally, the total number of embolisations is small (n=11 + 2 external LAAC devices).

Conclusion

Transcatheter retrieval of embolised devices is safe in most cases. Device retrieval from the LV carries a high risk of structural damage to valves and should prompt referral to cardiac surgery.

Impact on daily practice

These data and the educational moving images have instructional value for a planned retrieval procedure. Transcatheter retrieval of LAAC devices embolised to the LA or the aorta appears safe and feasible. Percutaneous device retrieval from the LV should not be considered, and patients should be referred for heart surgery.

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Conflict of interest statement

B. Schmidt has received speaker fees from Boston Scientific, Abbott and Lifetech. M. Piorkowski has received speaker's honoraria from W.L. Gore, C.R. Bard, Veryan Medical, and Philips B.V. The other authors have no conflicts of interest to declare.

References

1. Landmesser U, Schmidt B, Nielsen-Kudsk JE, Lam SCC, Park JW, Tarantini G, Cruz-Gonzalez I, Geist V, Della Bella P, Colombo A, Zeus T, Omran H, Piorkowski C, Lund J, Tondo C, Hildick-Smith D. Left atrial appendage occlusion with the AMPLATZER Amulet device: periprocedural and early clinical/echocardiographic data from a global prospective observational study. *EuroIntervention.* 2017;13:867-76.

2. Reddy VY, Doshi SK, Kar S, Gibson DN, Price MJ, Huber K, Horton RP, Buchbinder M, Neuzil P, Gordon NT, Holmes DR Jr; PREVAIL and PROTECT AF Investigators. 5-Year Outcomes After Left Atrial Appendage Closure: From the PREVAIL and PROTECT AF Trials. *J Am Coll Cardiol.* 2017;70:2964-75.

3. Tzikas A, Holmes DR Jr, Gafoor S, Ruiz CE, Blomström-Lundqvist C, Diener HC, Cappato R, Kar S, Lee RJ, Byrne RA, Ibrahim R, Lakkireddy D, Soliman OI, Nabauer M, Schneider S, Brachmann J, Saver JL, Tiemann K, Sievert H, Camm AJ, Lewalter T. Percutaneous left atrial appendage occlusion: the Munich consensus document on definitions, endpoints, and data collection requirements for clinical studies. *Europace.* 2017;19:4-15.

4. Boersma LV, Ince H, Kische S, Pokushalov E, Schmitz T, Schmidt B, Gori T, Meincke F, Protopopov AV, Betts T, Foley D, Sievert H, Mazzone P, De Potter T, Vireca E, Stein K, Bergmann MW; EWOLUTION Investigators. Efficacy and safety of left atrial appendage closure with WATCHMAN in patients with or without contraindication to oral anticoagulation: 1-Year follow-up outcome data of the EWOLUTION trial. *Heart Rhythm.* 2017;14:1302-8.

5. Aminian A, Lalmand J, Tzikas A, Budts W, Benit E, Kefer J. Embolization of left atrial appendage closure devices: A systematic review of cases reported with the watchman device and the amplatzer cardiac plug. *Catheter Cardiovasc Interv.* 2015;86:128-35.

Supplementary data

Supplementary Figure 1. Retrieval of a WATCHMAN device from the aorta.

Supplementary Figure 2. Percutaneous retrieval of a Coherex WaveCrest device from the aorta.

Supplementary Figure 3. Percutaneous retrieval of a LAmbre device from the aorta.

Supplementary Table 1. Procedural details of device salvage.

Moving image 1. Transseptal retrieval of an ACP from the LA via a steerable sheath. The disc's screw is snared to the IAS. Stepwise complete retraction of the disc and the lobe into the sheath. IAS: interatrial septum

Moving image 2. Percutaneous retrieval of a Coherex WaveCrest device from the aorta.

Moving image 3. Percutaneous retrieval of a LAmbre device from the aorta.

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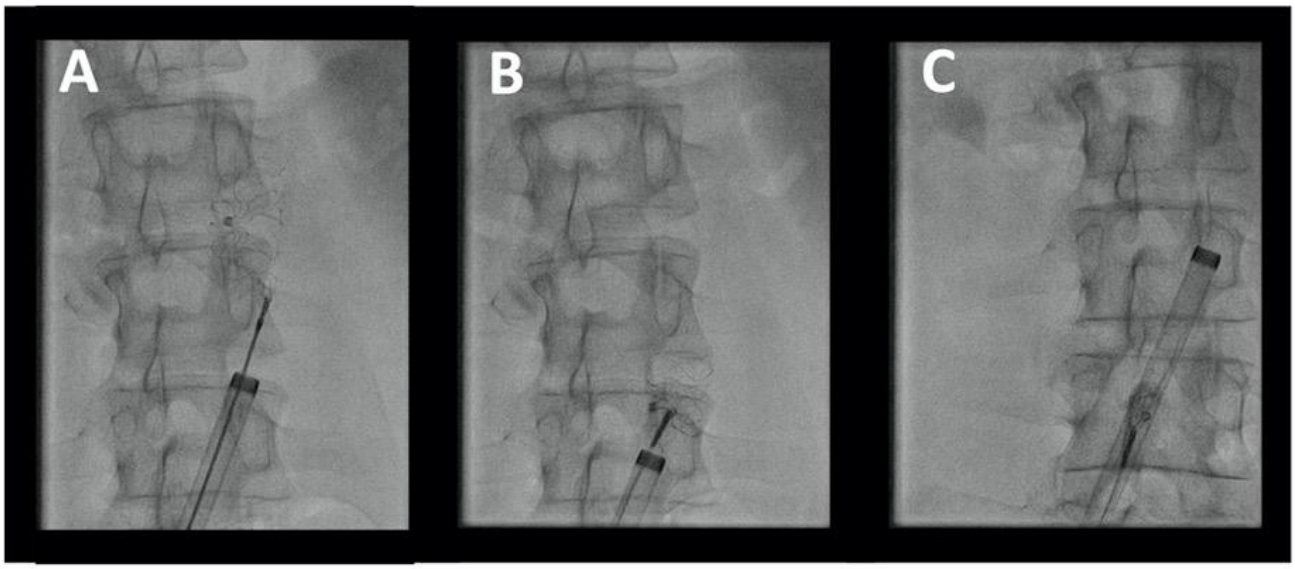
Supplementary data

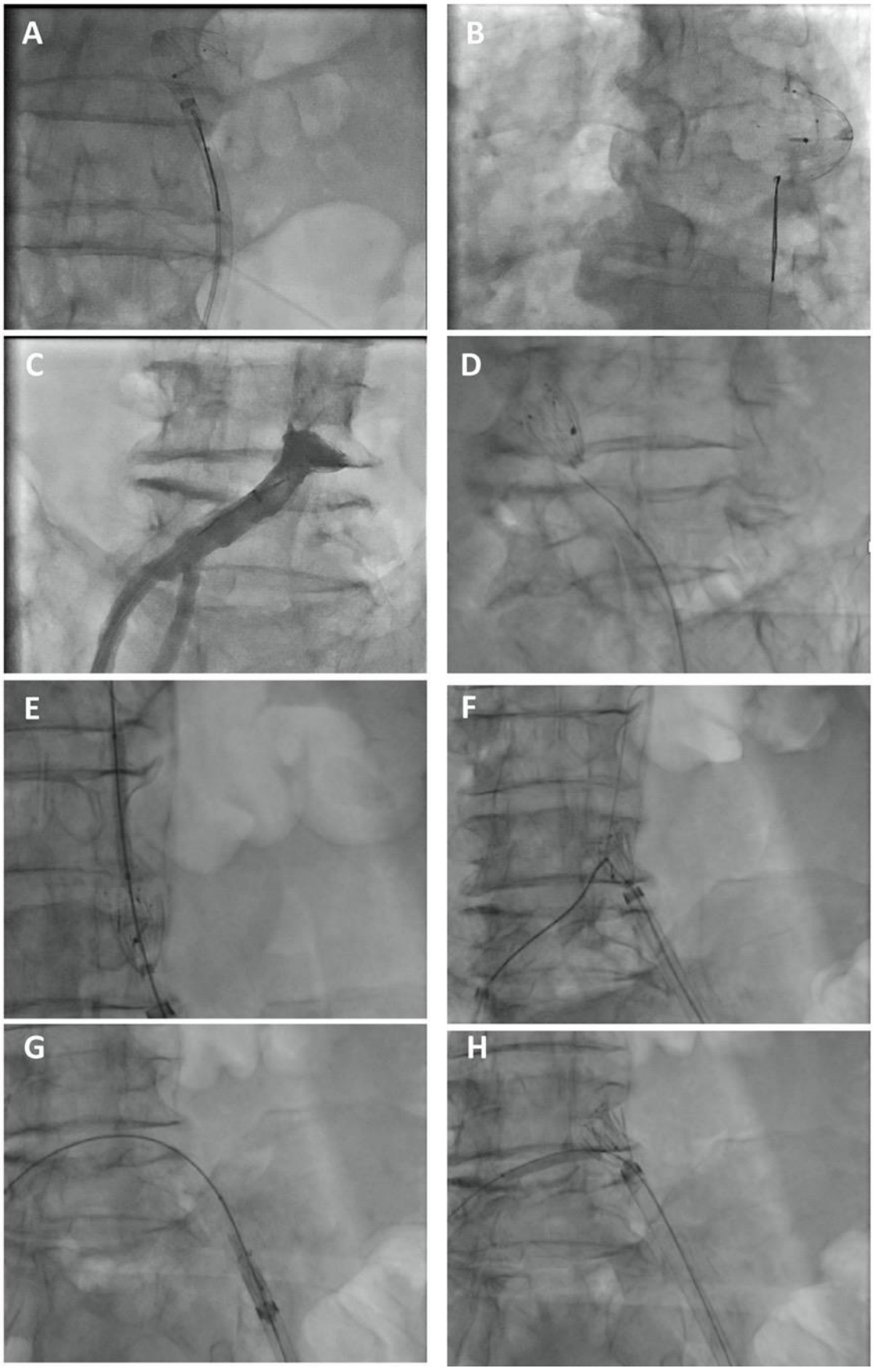


Supplementary Figure 1. Retrieval of a WATCHMAN device from the aorta.

A) Grabbing the device with forceps.

B) Re-sheathing into a 16 Fr sheath.

C) Successful retrieval.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Supplementary Figure 2/Moving image 2. Percutaneous retrieval of a Coherex WaveCrest device from the aorta.

A) A 12 Fr steerable sheath was advanced to the descending aorta and the device was snared (30 mm gooseneck snare).

B) Retraction into the sheath was not successful and the device was pulled towards the femoral access site.

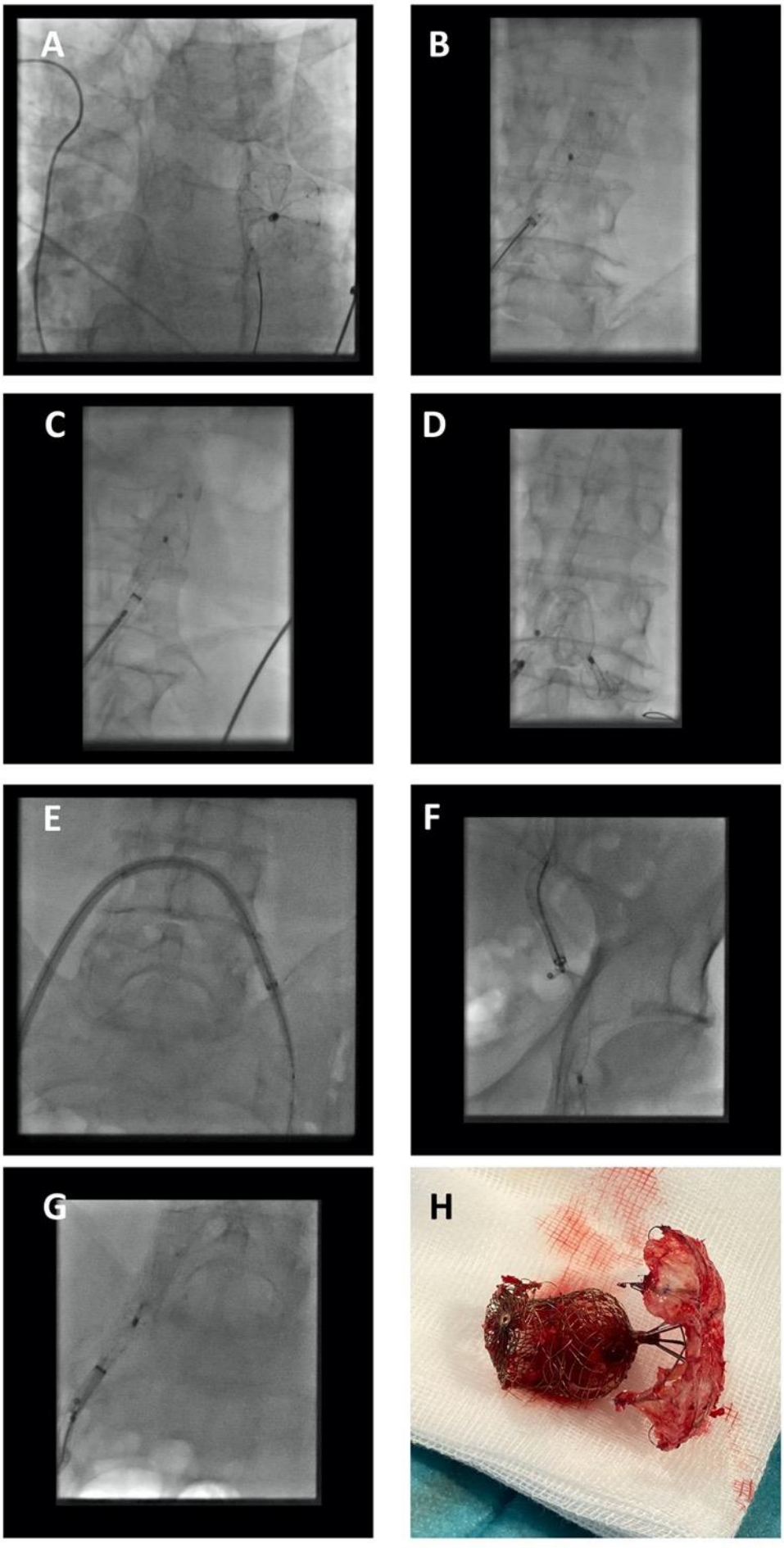
C) Unfortunately, the device was trapped at the aortic bifurcation and subtotally occluded the left common iliac artery.

D) After gaining left femoral arterial access the central hub of the device was wired.

E) A PTCA balloon was passed in an attempt to inflate it distally to pull the device into the sheath. However, balloons repeatedly ruptured.

F) Therefore, the wire was pulled to the right side (crossover).

G) & H) A balloon was used to push the device antegradely into the left-sided sheath.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Supplementary Figure 3/Moving image 3. Percutaneous retrieval of a LAmbre device from the aorta.

A) Snaring in the aortic arc with a 30 mm gooseneck snare.

B) Failed re-sheathing with a snare and (C) with forceps.

D) Failed re-sheathing after retraction to aortic bifurcation. After retraction to the left femoral artery (not shown).

E) A crossover of a 12 Fr steerable sheath was performed.

F) Successful re-sheathing.

G) Successful retrieval.

H) Explanted device.

Supplementary Table 1. Procedural details of device salvage.

Pat.	Device	LAA size	Time to dislo. (d)	Rhythm at implant.	Site of dislodgement	Sheath use for recovery	Snare kit type	Site of recovery	Retraction into sheath?	Perc. recovery successful?	Comment	Follow-up
1	30 mm ACP	24 mm	47	AF	LA	21 Fr E-valve for MitraClip	EN Snare 18 - 30 mm	Vein	Yes	Yes	Transient ST-elevation for 3 to 4 min	No LAAC, anticoagulation with low-dose NOAC
2	28 mm ACP	24 mm	1	AF	LA	12 Fr steerable	AMPLATZER 30 mm Gooseneck	Vein	Yes	Yes		Exitus letalis after TBI with ICB
3	22 mm ACP	17 mm	Intraproc.	SR	Aorta	12 Fr	AMPLATZER 30 mm Gooseneck	Artery	Yes	Yes		No LAAC, uneventful FU
4	25 mm Amulet	18 mm	Intraproc.	AF	LA + MV + IVC	12 Fr Cryoflex	AMPLATZER Microsnare 4 mm	Vein	Partially	Yes		Implantation 24 mm ACP 2 d later
5	28 mm Amulet	24 mm	Intraproc.	SR	LA > LV > Aorta	12 Fr Cryoflex	AMPLATZER 30 mm Gooseneck + EN Snare 2 - 4 mm + Myocard Biopsy Forceps	Artery	Yes	Yes		Implantation 24/30 mm Lifetech LAmbre 6 weeks later, uneventful FU
6	25 mm Amulet	18 mm	1	AF	MV > LV	15 Fr Cryoballoon right 12 Fr left	EP Cath in artery + EN Snare 18 - 30 mm	Vein and artery (failed)	No	No (referred to surgery)	CPR intraproc., severe damage to mitral valve, acute cardiogenic shock	Exitus letalis 3 weeks after intervention
7	25 mm Amulet	17 mm	1	SR	Partially in LA, still hooked in LAA	12 Fr laser	AMPLATZER 15 mm Gooseneck + Cook Vascular Retrieval Forceps + Myocard Biopsy Forceps	Vein	No	No	Initial implantation in external hospital, referred to us for device salvage Salvage failure	
8	24 mm WATCHMAN	21 mm	1	AF	Aorta	18 Fr	Biopsy Forceps + Snare	Artery	Yes	Yes	Initial implantation in external hospital, referred to us for device salvage	27 mm Coherex WaveCrest implantation 2 d after
9	21mm WATCHMAN	19 mm	1	SR	Aorta	16 Fr	Myocard Biopsy Forceps	Artery	Yes	Yes		2d after implantation 22 mm Coherex WaveCrest
10	24 mm WATCHMAN	19 mm	1	AF	LV below stenosed aortic valve	Surgery	AV replacement and device retrieval	LV	No	/	Referred for surgery	
11	27 mm Coherex WaveCrest	21 mm	Intraproc.	AF	LA	18 Fr 75° WaveCrest	AMPLATZER 30 mm + 15 mm Gooseneck + EN Snare 2 - 4 mm	Vein	No	Yes	Sudden cardiac death 1 week after discharge	No autopsy due to family wishes
12	27 mm Coherex WaveCrest	24 mm	Intraproc.	AF	Aorta	18 Fr left 12 Fr right	AMPLATZER 15 mm Gooseneck + Cook Vascular Retrieval Forceps	Artery	No	Yes	CIA dissection with PTA & stent implantation + stent graft into right femoral artery	Symptoms of peripheral artery disease 6 weeks later, no LAAC due to patient wishes
13	36/40 mm LAmbre	32 mm	1	AF	Aorta	12 Fr Cryoflex	AMPLATZER 30 mm Gooseneck + + Myocard Biopsy Forceps	Artery	Yes	Yes		Lariat or AtriClip planned

ACP: AMPLATZER Cardiac Plug; AF: atrial fibrillation; CIA: common iliac artery; d: days; dislo: dislocation; Fr: French; FU: follow-up; ICB: intracranial bleeding; LA: left atrium; LAA: left atrial appendage; LAAC: left atrial appendage closure; LV: left ventricle; MV: mitral valve; NOAC: non-vitamin K antagonist oral anticoagulants; Perc: percutaneous closure; PTA: percutaneous transcatheter angioplasty; SR: sinus rhythm; TBI: traumatic brain injury