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Percutaneous retrieval of patent foramen ovale closure device with snare after implantation: A case series

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Abstract

Patent Foramen Ovale (PFO) is common in the general population but can be frequently involved in cases of cryptogenic stroke. Its closure (PFOC) reduces the risk of recurrent strokes. In cases of residual shunt following implantation, percutaneous retrieval of the device by snare could be considered and feasible. Two hundred and fifty procedures were performed in our center, Institut Mutualiste Montsouris (Paris, France), between November 2015 and April 2024. We present 3 cases of percutaneous retrieval of previously implanted device using snaring technique. The procedures were performed using dedicated materiel, including 9F delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) and snare KIT 10 mm (Saint-Jude). Device retrieval was followed by the new implantation of Amplatzer Auricular Septal Defect (ASD) Occluder for interatrial communication or Amplatzer PFO Occluder Cribiform devices (Saint-Jude). There was no peri-procedural complications and excellent subsequent outcome. Our current series is the first to report the snaring procedure on previously implanted devices without embolization. In case of residual shunt following implantation of PFOC device, percutaneous retrieval of the device by snare could be considered and feasible using dedicated materiel with optimal results. In case of significant residual atrioseptostomy after retrieval of PFOC device, a device dedicated to interatrial communication closure could be deployed with optimal results. A Transseptal Puncture (TSP) near the PFO before PFOC can be usefull, especially in the case of “long-tunnel” PFO.

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Introduction

Patent Foramen Ovale (PFO) is common in the general population (20-25% of subjects were healthy) yet is frequently involved in cryptogenic strokes, a condition identified in 40-50% of patients with PFO. PFO can also be found in respiratory distress syndrome with platypnea-orthodeoxia [1]. In the case of a large PFO, associated or not with an atrial septal aneurysm, its closure (PFOC) with the help of a dedicated device reduces the risk of recurrent strokes compared to a medical treatment [2]. However, this procedure can have short- and long-term complications, including access site bleeding, post-procedural cardiac arrhythmias, pericardial effusion which is not unusual,

complete atrio-ventricular block requiring a permanent pacemaker, device-related endocarditis, device embolization/malposition, aorta erosion, recurrent strokes, device thrombosis or persistent interatrial shunt after implantation [3,4]. This latter complication is mostly related to inappropriate device positioning or sizing, leading to incomplete PFO closures that favour recurrent adverse clinical events. In fact, residual right-to-left shunts (rRLS) after PFOC are not uncommon, but large rRLS are rare [5]. Thus, retrieval of the device (either by surgical or a percutaneous approach) and subsequent defect corrections could be considered.

In this article, we present a single-centre retrospective analysis of this specific patient's subset. We retrospectively analysed the series of PFOC procedures performed in our institution, Institut Mutualiste Montsouris (Paris, France), between November 2015 and April 2024. We identified a total of n=250 PFOC procedures that were treated using the Amplatzer PFO Occluder device (Abbott Vascular, Santa Clara, California). All procedures were guided by Transesophageal Echocardiography (TEE) and angiography and performed under a general anaesthesia. In this cohort, we identified n=3 (1,2%) cases of post-PFOC persistent atrial septal residual shunt that led to percutaneous retrieval of the device.

To the best of our knowledge, our current series is the first to report the snaring procedure on previously implanted devices without embolization.

Case series

Case series investigations

The PFOC indication for the first patient, a 70-year-old female, with hypoxemic PFO and platypnea-orthodeoxia syndrome, revealed a PFO with an atrial septal aneurysm. A thoracic angioscan had previously been carried out and had ruled out pulmonary embolism.

The second patient, a 61-year-old male with regressive hemiplegia verified by Magnetic Resonance Imaging (MRI), had numerous ischemic strokes, including left pontine and right frontal, demonstrating PFO with an atrial septal aneurysm, according to the PFOC criteria. Holter Electocardiogram (ECG) monitoring was normal.

The PFOC indication for the third patient, a 53-year-old male with respiratory distress syndrome, revealed a PFO with a massive right to left shunt and an atrial septal aneurysm. A thoracic angioscan had previously been carried out, had ruled out pulmonary embolism and had discovered a left basal lung infectious disease treated with optiflow. Given the failure of optiflow and improvement in decubitus, a transthoracic echocardiography with a bubble test was performed and found PFO with massive shunt.

The devices used were respectively: Amplatzer PFO Occluder 35 mm (Abbott Vascular) (Figure 1), Amplatzer PFO Occluder Cribriform 30 mm (Abbott Vascular) (Figure 2) and Amplatzer auricular septal defect (ASD) Occluder 12 mm (Abbott Vascular) for interatrial communication (residual shunt at the beginning after Amplatzer PFO Occluder Cribriform 30 mm device (Abbott Vascular) not final primary implanted and therefore reinserted into the delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) because the device was not fully deployed) (Figure 3). The devices were deployed under a general anaesthesia with TEE guidance in a hybrid operating room (Table 1).

The reason for a residual shunt and hypoxemia due to a malposition was for the first patient a disproportionated right disc, which was not attached to the left disc due to an aortic misalignment caused by a diaphragmatic paralysis and aortic unrolling with constraint of the atrial septum in the anteroposterior plane (Figure 1).

The reason for a residual shunt because of a malposition was for the second patient a disharmonious left disc in the shape of a "Napoleon hat" due to the constraint tubular nature of the PFO and thick septum secundum preventing the two discs from pressing against each other (Figure 2).

For the third patient, a device opening too wide at its anteroposterior section against the aorta as a result of a gaping PFO and atrial septal aneurysm was the cause of a residual shunt and hypoxemia due to malposition (Figure 3).

Case series diagnosis

A multidisciplinary team of medical professionals, including interventional cardiologists, cardiac surgeons, ultrasound cardiologists and intensive care cardiologists, decided on percutaneous retrieval of PFOC device with a snare and a backup surgical extraction procedure in case of failure. This was carried out 5 days after the initial procedure for the first patient, due to an initial moderate clinical improvement with persistent moderate hypoxemia in the supine position as well as a cardiac scan at 48 hours confirming the presence of a non-occlusive prosthesis in TEE. For the second patient, the time delay remained the same as the first however for the third patient the procedure took place after 12 days.

We did not attempt to insert another device to perform a percutaneous PFO disc puncture. We tried the snaring manoeuvres with active surgical stand-by because of the risk of septal laceration.

Case series treatment

The procedures were performed under a general anaesthesia with TEE guidance (which ruled out device thrombus) in a hybrid operating room. The right common femoral vein was punctured under ultrasound guidance and closed with a Proglide 7STOMS1P (Abbott Vascular). A Check-Flow Performer Introducer 14F X 30 cm (Cook) was introduced. A bolus of unfractionated heparin (100 UI/kg) was provided. The 9F delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) was brought into contact with the device. A snare KIT 10 mm (Saint-Jude) was used to grasp the nitinol protruding section at the surface of the device's right disc. The whole system was then pulled back after bringing the 9F delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) into contact with the device to reintegrate the device into the delivery sheath Amplatzer (Saint-Jude). The subsequent steps varied as a function of the observed results on the interatrial septum.

For the first patient, a significant residual atrioseptostomy was observed. The Amplatz Extra Rigide 260 cm - curve 3 mm wire (Cook) was placed in the upper left pulmonary vein. After sizing with a Balloon 24 (Saint-Jude), Amplatzer ASD Occluder 20 mm device (Saint-Jude) for interatrial communication was delivered across an Agilis 8,5F X 0,91 m (Saint-Jude) and successfully deployed without residual significant septal defect (Table 1) (Figure 1).

For the second and third patients, an additional transseptal puncture was performed near the PFO (5 millimetres lower and

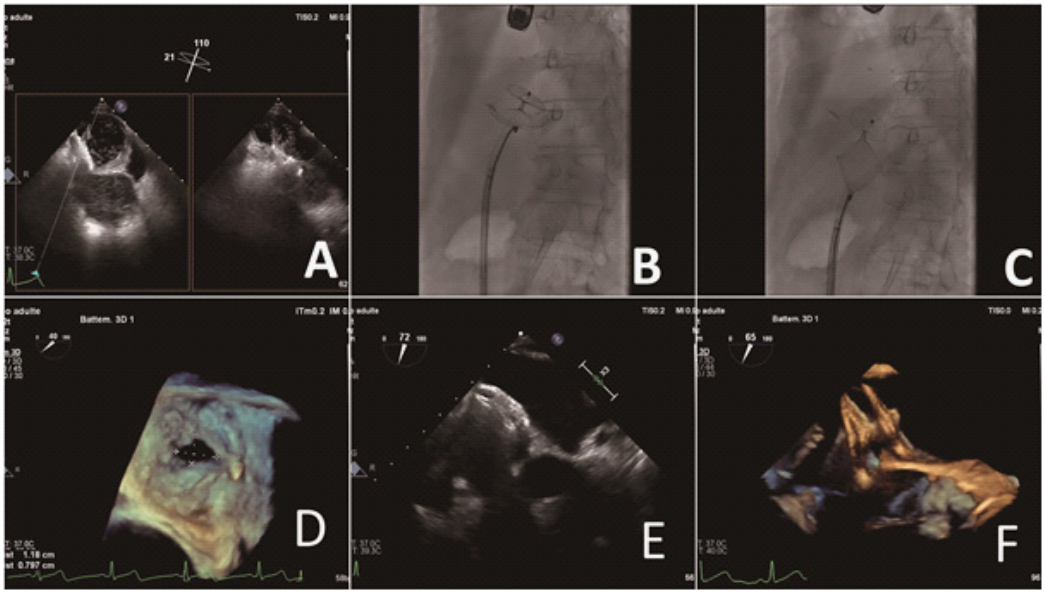

Figure 1: A: Amplatzer PFO Occluder 35 mm device (Abbott Vascular) was deployed but a residual shunt was observed in TEE with a bubble test.

B: Because of a residual shunt, the device was extracted 5 days later by Snare KIT 10 mm (Saint-Jude), which was used to grasp the nitinol protruding section at the surface of the device's right disc, guided by angiography.

C: The whole system was pulled back after bringing the 9F delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) into contact with the device, to reintegrate the device in the delivery sheath Amplatzer (Saint-Jude), guided by angiography.

D: The device extraction was complicating itself with a lesion of the interatrial septum in 3 Dimensions (3D) TEE.

E: A new Amplatzer ASD Occluder 20 mm device (Saint-Jude) for interatrial communication was deployed with success in TEE.

F: A new Amplatzer ASD Occluder 20 mm device (Saint-Jude) for interatrial communication was deployed with success in 3D TEE.

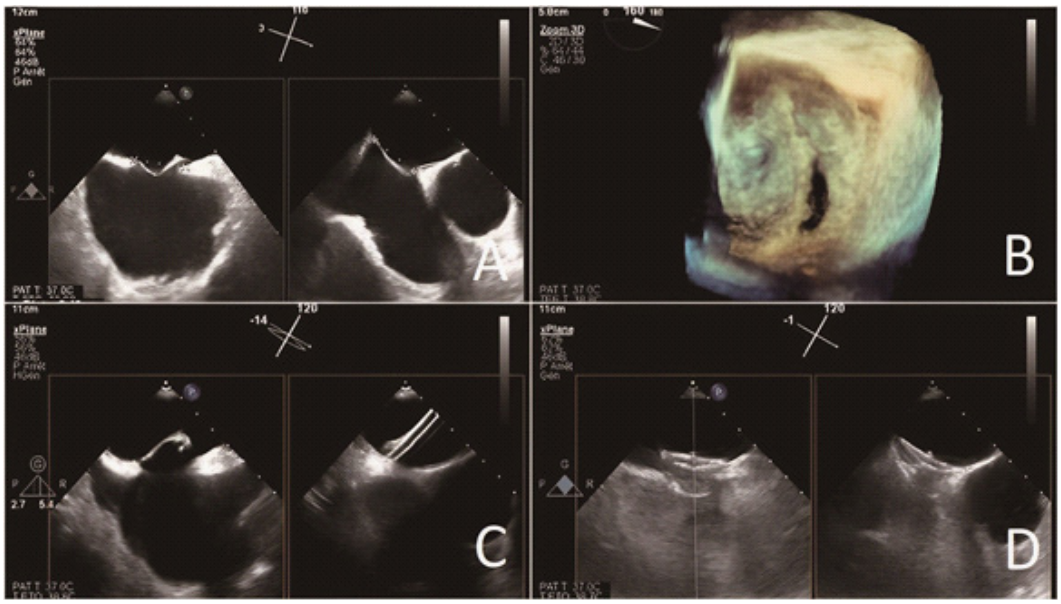

Figure 2: A: There is a tunnelled PFO in TEE.

B: There is a tunnelled PFO in 3D TEE.

Amplatzer PFO Occluder Cribriform 30 mm device (Abbott Vascular) was deployed. Because of a residual shunt, the device was extracted during the same procedure by Snare KIT 10 mm (Saint-Jude). A residual shunt was observed after device extraction in TEE.

C: We visualised the transseptal delivery sheath Amplatzer (Saint-Jude) in TEE.

D: Amplatzer PFO Occluder Cribriform 30 mm device (Abbott Vascular) was deployed a second time with success in TEE.

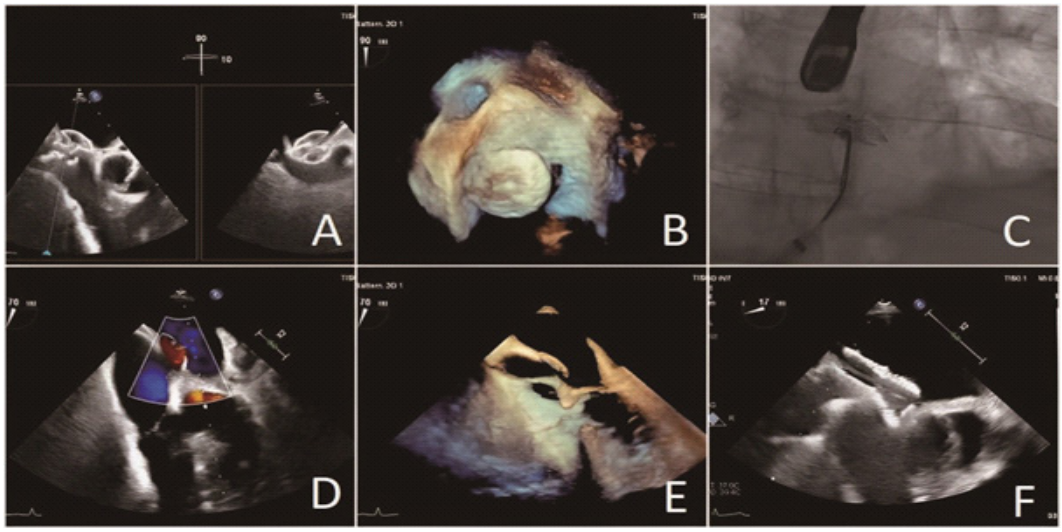

Figure 3: A: Amplatzer ASD Occluder 12 mm device (Abbott Vascular) for interatrial communication was deployed but a residual shunt was observed in TEE.

B: A residual shunt was observed in 3D TEE.

C: Because of a residual shunt and hypoxemia, the device was extracted 12 days later by Snare KIT 10 mm (Saint-Jude), which was used to grasp the nitinol protruding section at the surface of the device's right disc, guided by angiography.

D: A massive shunt was observed in TEE.

E: A massive shunt was observed in 3D TEE.

F: A new Amplatzer PFO Occluder Cribriform 30 mm device (Abbott Vascular) was deployed with success in TEE.

Table 1: Timeline of 3 patient case series.

	Patient 1	Patient 2	Patient 3
Sex	Female	Male	Male
Age	70	61	53
Date first procedure	June 2019	December 2019	May 2020
First device	Amplatzer PFO Occluder 35 mm	Amplatzer PFO Occluder Cribriform 30 mm	Amplatzer ASD Occluder 12 mm
Date second procedure	5 days after	Same day	12 days after
Second device	Amplatzer ASD Occluder 20 mm	Amplatzer PFO Occluder Cribriform 30 mm	Amplatzer PFO Occluder Cribriform 30 mm

posterior, given the difficulty of carrying out the procedure via the PFO) in the atrial septal aneurysm with the PKG Assy Transseptal Needle 71 cm BRK, G2 (Saint-Jude) in the Swartz braided transseptal sl 8,5F/6,3 cm (Saint-Jude). The Amplatz Extra Rigide 260 cm - curve 3 mm wire (Cook) was placed in the upper left pulmonary vein. The 9F sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) was easily delivered to the left atrium. Amplatzer PFO Occluder Cribiform 30 mm devices (Saint-Jude) were successfully deployed without a significant residual septal defect (Table 1) (Figures 2,3).

Case series follow-up and outcomes

The immediate and 1-year clinical results of the 3 patients were satisfactory. For the first and third patients, respiratory distress syndrome disappeared immediately after the procedures, with no recurrence even after 1 year. For the second patient, there was no recurrence of stroke after 1 year. There were no adverse events for the 3 patients after 1 year.

Ultrasound results after 1 year were satisfactory with endothelialisation of PFOC devices, without a residual shunt.

After six weeks of Dual Antiplatelet Therapy (DAPT), the three patients received only a long-term aspirin treatment alone.

Discussion

Malposition after PFOC is a well-known but an infrequent complication (0,13% in published meta-analyses) [6]. Embolization after PFOC is more frequent and described in the scientific literature [7]. The role of the ultrasound cardiologist is crucial in this procedure. The choice of PFOC device size is essential, as it should be neither too large because of the risk of malposition and rRLS nor too small because of the risk of embolization. Sometimes, a Transseptal Puncture (TSP) near the PFO is necessary, especially in the case of "long-tunnel" PFO [6]. One of the pitfalls of this procedure is an underestimate of rRLS after PFOC, which is sometimes difficult to quantify in patients under general anaesthesia.

In our cases, we explain the higher frequency (1,2%) of complications because our hospital is a centre with a relatively small volume of PFOC, with some cardiologists at the beginning of their learning curve. It would have been preferable if an experienced proctor from our cardiologic centre (or from another cardiologic centre if not possible) had been present during all the initial procedures. Thus, this procedure should only be performed in dedicated centres to ensure adequate procedural

volume, or indeed by operators with a minimum level of experience.

In our cases, we used the snare technique. The best way to grab the device with the snare is to grasp the nitinol-protruding section at the surface of the device's right disc, guided by angiography. It is the easiest part of the device to catch. The important point to prevent additional complications with the PFOC device retrieval is that the 9F delivery sheath Amplatzer AGA TorqVue 45 degrees (Saint-Jude) is in contact with the snare attached to the device to avoid any risk of embolization. There is no case series reported in the scientific literature of percutaneous PFOC device retrieval by snare for malposition (only reported for embolization) [7]. Our case series demonstrates the feasibility of percutaneous retrieval of PFOC device with a dedicated technique, especially with a snare, and a percutaneous implantation of a new device. However, cases of multiple device implantations after percutaneous treatment of multiple auricular septal defects have already been described [8].

Conclusion

All the three interventional procedures were carried out without complication. The first and third patients felt a clear clinical improvement. The second patient had no recurrence of stroke. Thus, the device can be safely retrieved percutaneously with the use of a snare in the event of non-satisfactory results after PFOC, followed by a new PFOC with a new PFO or ASD closure device for interatrial communication.

Learning points

In case of residual shunt following implantation of PFOC device, percutaneous retrieval of the device by snare could be considered and feasible using dedicated materiel with optimal results. In case of significant residual atrioseptostomy after retrieval of PFOC device, a device dedicated to interatrial communication closure could be deployed with optimal results. A TSP near the PFO before PFOC can be usefull, especially in the case of "long-tunnel" PFO.

Declaration

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Conflicts of interest: None.

Informed consent: All patients agreed to take part anonymously in our case series. The authors confirm having received patients' consent according to COPE guidelines.

Author contributions: QL, AV, CD, CC and NA have participated in writing the article and have performed the procedures.

Data availability: It is not ethically feasible for authors to make all data and software code on which the conclusions of the paper are available to readers.

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