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CASE REPORT
Congenital heart disease

Patent foramen ovale closure in a patient with vena cava filter: a case report

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Background The presence of a patent foramen ovale (PFO) is associated with several medical conditions, including cryptogenic left circulation thromboembolism. PFO closure was demonstrated to reduce recurrent ischaemic stroke in patients with prior cryptogenic stroke. The presence of an inferior vena cava filter (IVCF), however, may impede a transfemoral PFO closure procedure.

Case summary We describe the case of a 50-year-old man with a PFO suffering from ischaemic stroke from paradoxical thromboembolism originating from deep vein thrombosis and requiring an IVCF. After deep vein thrombosis resolution, due to the high risk of stroke recurrences, the patient was recommended PFO closure. IVCF retrieval by the interventional radiologist was first attempted but failed. A transfemoral PFO closure procedure was thus endeavoured with the IVCF in place and was successful. The patient was then discharged in good clinical status and no stroke recurrences were reported at 5 months follow-up.

Discussion Albeit an IVCF provides benefit in patients with recurrent thromboembolic events despite adequate anticoagulation therapy, its presence may hinder interventional procedures necessitating delivery systems to advance through the inferior vena cava. We reported on a successful PFO closure procedure via a femoral venous access in a patient with an IVCF in place, thus demonstrating the feasibility of advancing delivery systems through an IVCF. As interventional procedures requiring the advancement of delivery systems through the inferior vena cava are becoming increasingly common, the feasibility of IVCF crossing with catheters and delivery systems alike paves the way for novel interventional possibilities.

Keywords Patent foramen ovale • PFO closure • Vena cava filter • Paradoxical embolism • Case report

Learning points

- Patent foramen ovale (PFO) closure reduces recurrent ischaemic strokes in patients with a prior cryptogenic stroke.
- Albeit the presence of an inferior vena cava filter (IVCF) may hinder interventional procedures requiring a venous transfemoral approach, advancing a PFO occlusion device through an IVCF is feasible.
- Procedures requiring delivery systems to advance through an IVCF may be attempted in selected cases.

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Introduction

The presence of a patent foramen ovale (PFO) is associated with several medical conditions, including cryptogenic left circulation thromboembolism. PFO closure was demonstrated to reduce recurrent ischaemic stroke in patients with prior cryptogenic stroke.[1–4] The presence of a venous source of embolism at the time of the stroke or previous occurrence of pulmonary embolism strongly suggest paradoxical embolism in PFO patients.[1] Notwithstanding, patients with contraindications for oral anticoagulation or recurrent venous thromboembolism despite adequate anticoagulation therapy may have been implanted an inferior vena cava filter (IVCF), which proves a challenge for interventional procedures going through the inferior vena cava.[5,6]

Timeline

27 February 2020	Ischaemic thromboembolic stroke in the regions of the left lenticular nucleus and the temporal ramification of the right middle cerebral artery. Subsequent echocardiographic examination showing the presence of a patent forame ovale (PFO) with massive right-to-left passage of contrast-enhanced micro-bubbles through the PFO at rest
02 March 2020	Inferior limb venous ultrasound showing the presence of deep vein thrombosis in the popliteal and gemellary veins
05 March 2020	Inferior vena cava filter (IVCF) positioning
11 August 2020	Hospital admission
12 August 2020	Venous Doppler ultrasound of the inferior limbs showing complete thrombi resolution. Subsequent failed attempt of IVCF removal
13 August 2020	Successful PFO closure procedure with the Amplatzer device
14 August 2020	Transthoracic echocardiography showing a correctly positioned Amplatzer device on the interatrial septum with no shunt at the colour-Doppler imaging
17 August 2020	Hospital discharge
15 January 2021	Patient in overall good conditions with no ischaemic recurrences nor hospital re-admissions

Case presentation

A 50-year-old man with prior smoking habit and otherwise unremarkable clinical history suffered a massive ischaemic stroke in the left lenticular and right temporoparietal regions causing right hemiparesis and dysarthria. On examination, the cardiac tones were regular with no murmurs and normal breath sounds were heard over all the lung fields. Elevated blood levels of D-dimer (1135 ng/mL, normal reference values < 510 ng/mL) and C-reactive protein (34.7 mg/L, normal reference values < 5.0 mg/L) were found, while the remainder of the laboratory values were within normal range; specifically, haemoglobin was 13.6 g/dL, white blood cells count 9760/mL, and creatinine 0.6 mg/dL. Due to the young age of the patient and no apparent provoked mechanism of thromboembolism, thrombophilia screening was performed and only showed a borderline positivity for Lupus anticoagulant antibodies. Cerebral vascular disease was ruled out by means of magnetic resonance imaging. Transcranic and transesophageal echocardiography demonstrated the presence of a PFO with transient massive (grade 3) right-to-left passage of contrast-enhanced micro-bubbles at basal conditions;[7] moreover, screening venous ultrasound examination of the inferior limbs documented the presence of popliteal vein thrombosis in the right inferior limb 6 days following the stroke event. Due to the absence of haemorrhagic content in the ischaemic cerebral lesion, after neurologist consultation, the patient was started on anticoagulation therapy with low molecular weight heparin; however, the inferior limbs' venous thrombus was almost unchanged at the control venous ultrasound performed 3 days later. Due to the high risk of stroke recurrences due to paradoxical thromboembolism through the PFO (Risk of Paradoxical Embolism score: 6) should the inferior limbs' thrombus migrate,[8] after risk/benefit assessment and patient consultation, a Denali™ IVCF was positioned by the interventional radiologist (*Figure 1*). No episodes of atrial fibrillation were recorded at the in-hospital electrocardiogram monitoring during the 10-day hospitalization for stroke, thus it was not deemed necessary to further assess the potential presence of atrial fibrillation by means of event recorders. After a few months of adequate antithrombotic therapy with warfarin at therapeutic range (target international normalized ratio of 2.0 to 3.0) and deep vein thrombosis resolution, as assessed at the venous

Figure 1 Picture of a Denali™ inferior vena cava filter.

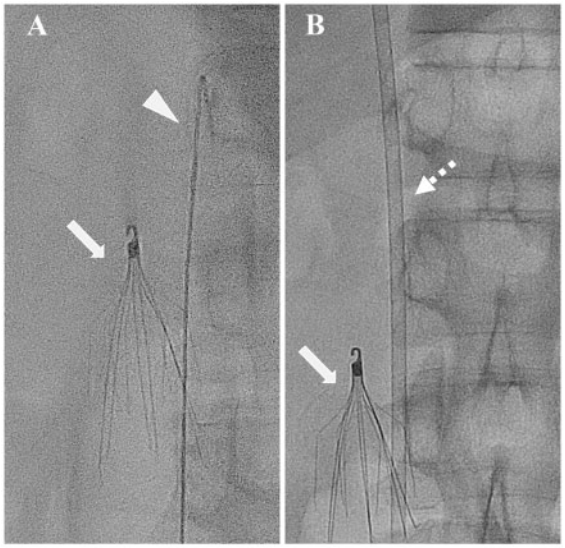
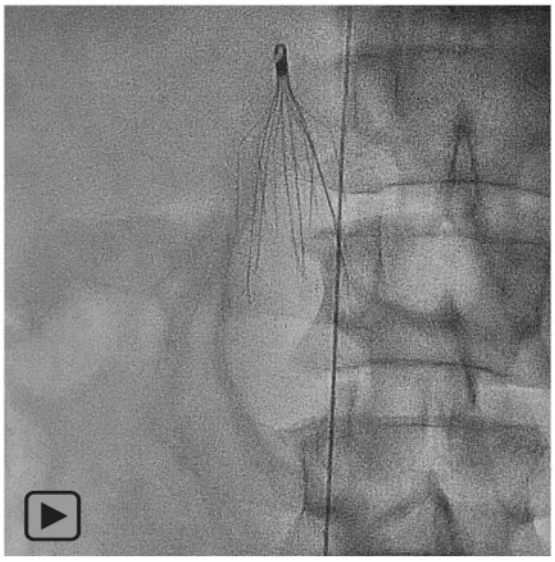
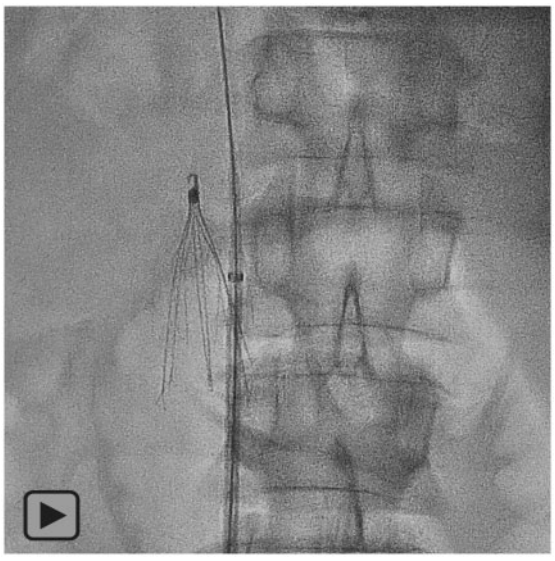


Figure 2 Angiographic images showing the guidewire passage through the inferior vena cava filter (*A*) and the Amplatzer patent foramen ovale occluder delivery system crossing the inferior vena cava filter (*B*). The filled arrow indicates the inferior vena cava filter; the arrowhead designates the guidewire; the dotted arrow points at the Amplatzer patent foramen ovale occluder delivery system.



Video 1 Guidewire passage through the inferior vena cava filter.



Video 2 Amplatzer delivery system advancing through the inferior vena cava filter.

ultrasound, the patient was recommended IVCF retrieval and PFO closure, due to the high risk of recurrent ischaemic strokes in this scenario.[1]

On presentation, the patient was eupnoeic and apyretic. He still complained of slight speech disorders and mild right hemiparesis, which had been present since the time of the stroke, albeit slowly ameliorating. Vital signs were within normal limits. Cardiac tones were regular, and no signs of heart failure were noticed. IVCF removal by the interventional radiologist was first attempted but failed, as tip of the IVCF was stuck to the wall of the vessel and it could not be caught and retrieved; nevertheless, the IVCF was still functional after the failed retrieval attempt. However, due to the high thromboembolic risk from deep vein thrombosis originating in body districts other than the lower limbs, after patient consultation and agreement, the PFO closure procedure was endeavoured. After right common femoral vein puncture and sheath positioning, 5000 international units of unfractionated heparin were administered and a guidewire was advanced up to the level of the IVCF and oriented towards the outer part of the IVCF, where the cells are more distant and wider. Careful guidewire positioning and moving allowed successful upward passage of the wire across the VCF (*Figure 2A* and *Video 1*). An 8-Fr 25-mm Amplatzer PFO occluder delivery system was then advanced on the guidewire and gently pushed across the IVCF (*Figure 2B* and *Video 2*) and into the right atrium. Correct Amplatzer PFO occluder positioning was ascertained through fluoroscopy and transoesophageal echocardiography guidance (*Figure 3*); the device was then delivered and the catheter safely withdrawn without complications (*Figure 4* and *Video 3*). Due to the successful procedure of PFO closure and the presence of an IVCF, warfarin was stopped after the procedure and the patient was started on double antiplatelets therapy. The echocardiographic examination demonstrated correct positioning of the Amplatzer device.

The patient was discharged in good clinical status on Day 4 following the procedure, when the neurological centre could readmit him to carry on his rehabilitation programme after the stroke event. At 5 months follow-up the patient was alive and well, with no ischaemic or thromboembolic recurrences.

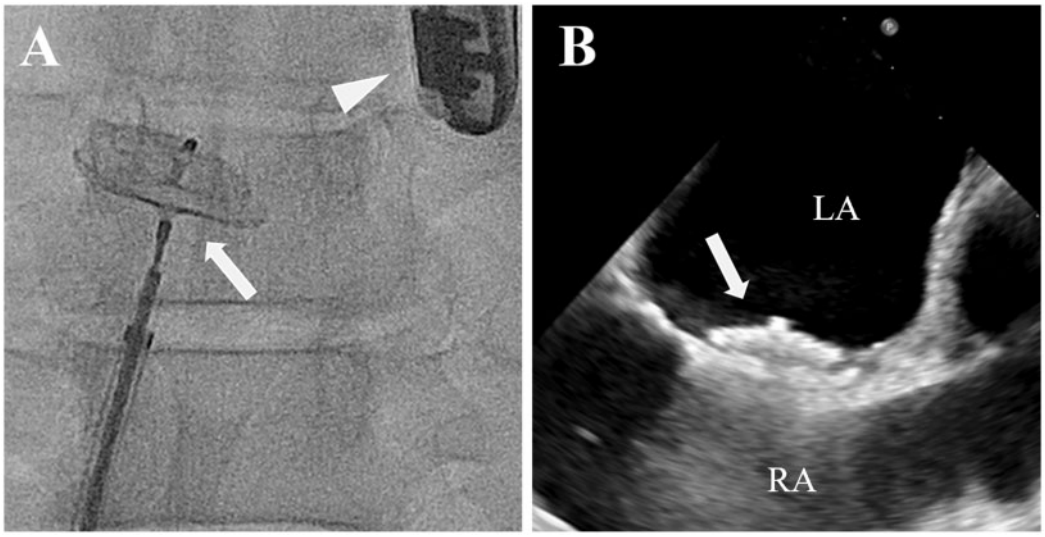


Figure 3 Fluoroscopy image (*A*) and transesophageal bicaval view (*B*) showing the correct positioning of the Amplatzer device at the interatrial septum level. The filled arrow indicates the Amplatzer patent foramen ovale occluder device; the arrowhead points at the transesophageal probe. LA, left atrium; RA, right atrium.

Discussion

IVCFs are usually indicated for patients at high risk of venous thromboembolism who have absolute contraindications to anticoagulation or exhibit recurrent thromboembolic events despite adequate anticoagulation therapy.[5,6,8–10] Albeit an IVCF provides benefit in these scenarios, its presence may hinder interventional procedures necessitating delivery systems to advance through the inferior vena cava.

Standard PFO closure procedures are performed through a femoral approach, as atrial access through the inferior vena cava provides an adequate angle for easily orienting and crossing the guidewire into the left atrium. Few alternative venous approaches have been described to circumvent the presence of an IVCF during PFO closure procedures, with the left axillary vein, the right internal jugular venous, or the hepatic vein being seldom utilized.[11–14] Nevertheless, albeit reports of interventional procedures performed through a femoral venous access in patients with an IVCF exist, a successful transfemoral PFO closure procedure in the presence of an IVCF has been rarely described.[15,16] The present case provides further evidence regarding the feasibility of advancing a PFO occlusion device through an IVCF, thus hinting that a femoral approach may still be preferred in this setting. Moreover, as interventional procedures requiring the advancement of delivery systems through the inferior vena cava are becoming increasingly common, the feasibility of IVCF crossing with catheters and delivery systems alike paves the way for novel interventional possibilities. Careful advancement of a hydrophilic guidewire in the outer segments of a Denali™ filter, where its cells are wider, is paramount for the success of the procedure. However, as the present intervention was conducted in the presence of a Denali™ IVCF, the good results of this report may not be reproducible with other types of IVCF in place.

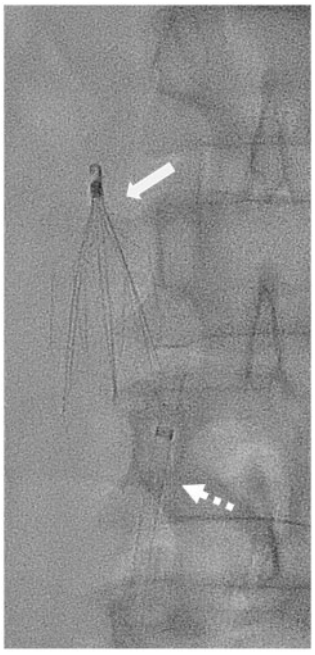
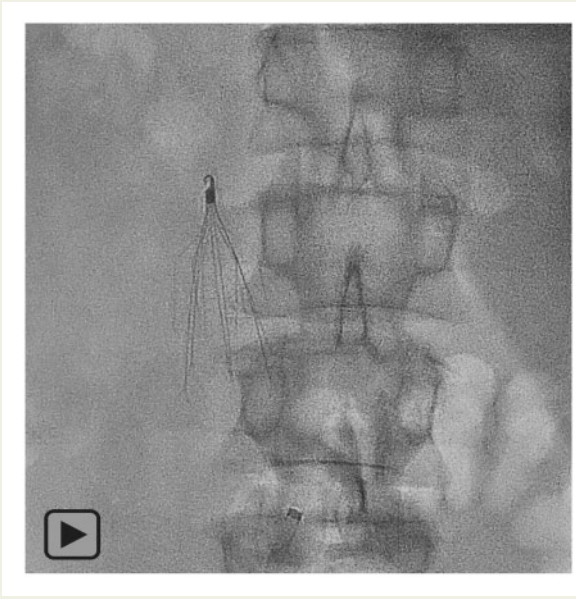


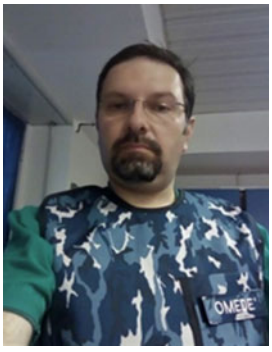
Figure 4 Fluoroscopy image depicting safe withdrawal of the catheter through the inferior vena cava filter. The filled arrow indicates the inferior vena cava filter; the dotted arrow points at the Amplatzer patent foramen ovale occluder delivery system.

This case demonstrates that positioning a PFO occlusion device through an IVCF is feasible and provides additional evidence that procedures requiring delivery systems to advance through an IVCF may be attempted in selected cases.



Video 3 Catheter withdrawal through the inferior vena cava filter.

Lead author biography



Dr Pierluigi Omedè was born on 6 May 1974, graduated at University of Turin, Italy in 1999 and post-graduated in Cardiovascular Medi cine in 2003. In over 15 years of experience as Interventional Cardio logist, he performed over 5000 left heart catheterizations and more than 2000 PCIs as first operator, with about 200 percutaneous coronary interventions/year since 2005. He has experience in complex coronary and structural interventions including bifurcation and left main revascularization, anterograde total occlusion, rotational atherectomy, transcatheter aortic valve implantation, and MitraClip procedures. In the last 10 years he has paid particular attention to interventions of percutaneous closure of PFOs and atrial septal defects.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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