

# A ‘twice closed’ patent foramen ovale: a case report of percutaneous management of a residual interatrial shunt in a patient with persistent migraine symptoms

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## Background

Residual interatrial shunt following percutaneous patent foramen ovale (PFO) closure is a rare complication that can be associated with persistent migraine.

## Case summary

A 32-year-old woman with a history of percutaneous PFO closure due to a previous coronary paradoxical embolism and a condition of drug-refractory migraine underwent transoesophageal echocardiography (TOE) to investigate further recurrent migraine attacks. A partial displacement of a PFO occluder device was found, and it was successfully treated through the fluoroscopic and TOE-guided positioning of a second occluder in overlap with the previous one. The patient reported no more migraine attacks at the 6-month follow-up visit.

## Discussion

Residual interatrial shunt should be suspected in patients with persistent migraine and a history of percutaneous PFO closure. Fluoroscopic and TOE-guided closure of residual interatrial shunt with a second PFO occlude device seems to be a safe and clinically effective strategy to manage persistent migraine.

## Keywords

Patent foramen ovale • Migraine • Imaging • PFO closure • Interatrial shunt • Case report

## ESC curriculum

2.2 Echocardiography • 9.7 Adult congenital heart disease • 2.1 Imaging modalities

## Learning points

- Residual interatrial shunt should be a differential diagnosis in patients with persistent migraine and a history of percutaneous patent foramen ovale (PFO) closure.
- Percutaneous treatment of a residual interatrial shunt by positioning a second PFO occluder device seems to be a safe and effective strategy to reduce migraine attacks with intraprocedural transoesophageal echocardiography as fundamental tool to correctly guide the procedure.

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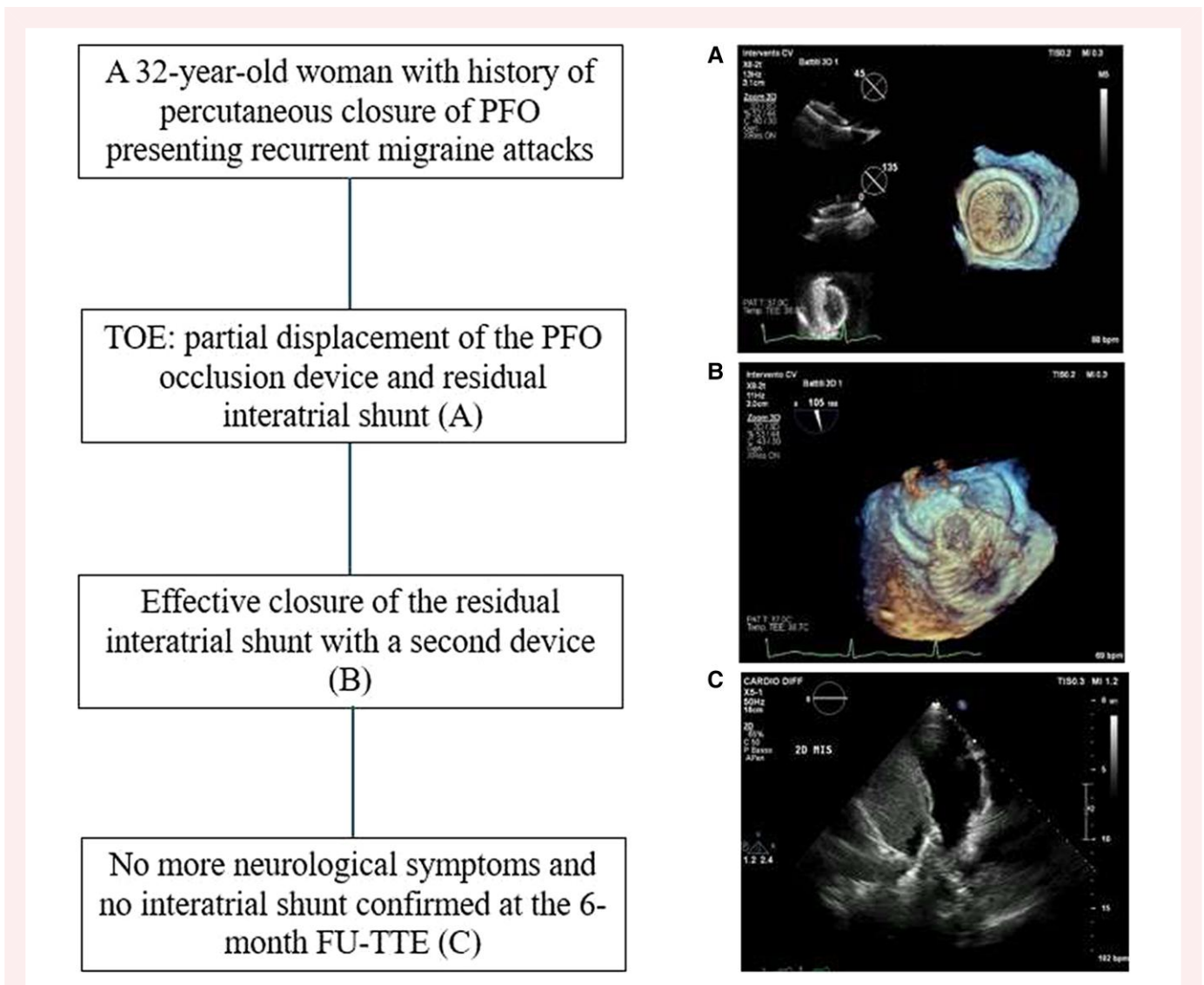
## Introduction

The patent foramen ovale (PFO) is a cardiac congenital defect present in 20–25% of the adult population associated with left circulation embolism and migraine (especially with aura).<sup>1,2</sup> Migraine is a common chronic neurovascular disorder characterized by recurrent, self-limited, headaches associated with autonomic symptoms (nausea, vomit, photophobia, and/or phonophobia). About 5% of migraine cases are refractory,<sup>3</sup> meaning that they fail to respond to all classes of preventive drugs<sup>3</sup>; in this setting, patients may be screened for a possible non-pharmacological management. Previous studies showed that migraine is more prevalent in patients with PFO<sup>4</sup>; the most likely pathophysiological mechanism linking the PFO to migraine onset is *paradoxical embolism*: small emboli pass into the systemic circulation through the PFO triggering low perfusion or cortical spreading depression and

thus causing migraine attacks.<sup>5</sup> Moreover, it was hypothesized that the transition of some vasoactive substances from the right to the left atrium, bypassing the pulmonary circulation where they are physiologically metabolized, is a possible cause of migraine attacks.<sup>5</sup> Patent foramen ovale percutaneous closure has been reported as a potential beneficial strategy in case of drug-refractory migraine, being able to reduce both monthly migraine attacks and monthly migraine days, but not total attacks, with residual interatrial shunt (IAS) present in more than 90% of cases at one-year follow-up (FU), possibly due a partial or complete device displacement secondary to an incomplete endothelization.<sup>6–8</sup>

We present a case of a 32-year-old woman, with a history of percutaneous PFO closure due to a previous coronary paradoxical embolism and a condition of drug-refractory migraine, who subsequently presented further recurrent migraine attacks with aura associated with a partially displaced PFO occlusion device and a residual IAS.

## Summary figure



(A) 3D-MultiView of a partially displaced Amplatzer PFO Occluder device; (B) 3D-zoom volume rendering of two Amplatzer PFO Occluder devices implanted in overlap to treat a residual interatrial shunt following a percutaneous PFO closure.

## Case description

The patient was a 32-year-old woman with a previous history of refractory migraine with aura, suffering from about five attacks per month, with a known ‘tunnel-like’ PFO associated with atrial septum aneurysm. After one year of no response to the neurological preventive therapy (including amitriptyline, topiramate, and verapamil), with a brain magnetic resonance showing multiple ischaemic lesions and an episode of coronary paradoxical embolism complicated by myocardial infarction, she was treated by positioning of an Amplatzer PFO Occluder 25 mm (Abbott, Chicago, IL, USA) in 2019. She presented normal physical examination, normal blood count, normal parameters of kidney and liver function, and a negative thrombophilia screening. After the procedure, she started chronic therapy with acetylsalicylic acid (ASA) 100 mg once daily with an initial decrease of the frequency of headaches (one every six months). No residual IAS was described at one-month follow-up transoesophageal echocardiography (TOE), although images and videos of the exam were not available.

From October 2022, she experienced worsening of the migraine symptoms with almost daily attacks, in absence of cerebrovascular or cardiovascular events. So, the patient was referred by the neurologist to our Echo Laboratory to perform a TOE to complete the diagnostic workup in December 2022.

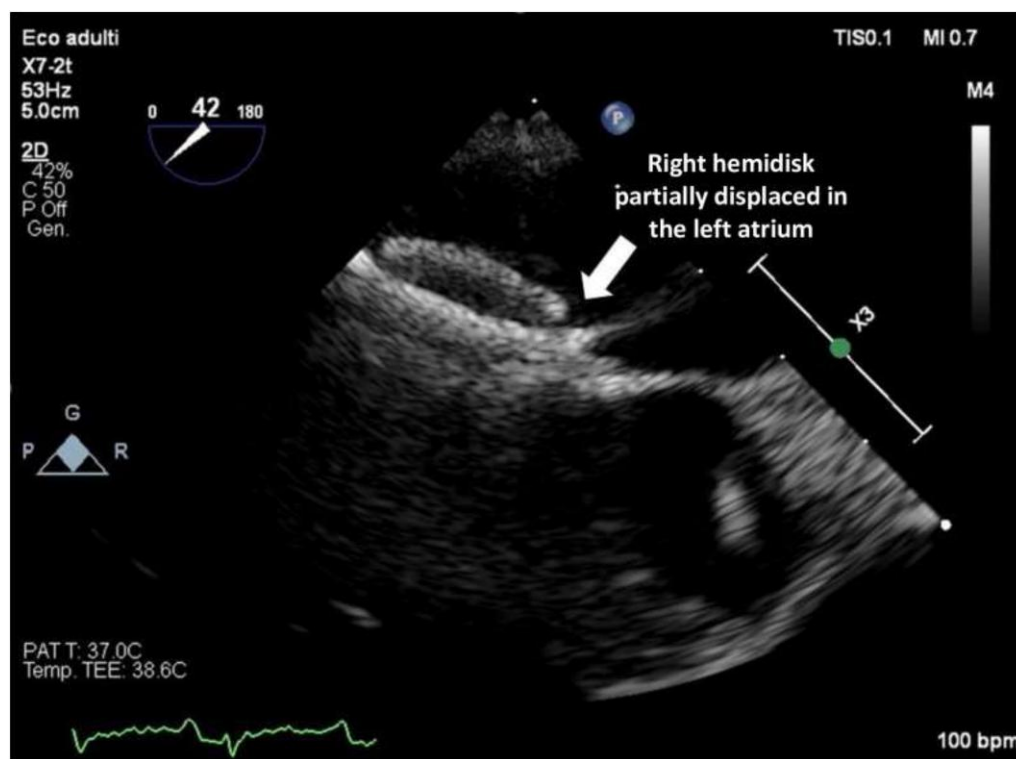
The TOE exam revealed an exceptional and unexpected finding: a partial displacement of the Amplatzer PFO Occluder into the left atrium, with the half of the right disk that was detached from the septum primum (Figure 1, Supplementary material online, Video S1). The colour Doppler evaluation was not able to identify right-to-left IAS, but the micro-bubble test detected a right-to-left shunt during Valsalva manoeuvre (Figure 2, Supplementary material online, Video S2).

The case was discussed by the Multidisciplinary Heart Team that decided to close percutaneously the interatrial communication through the positioning of a second PFO occlusion device because of the good visualization of the IAS at the bubble test.

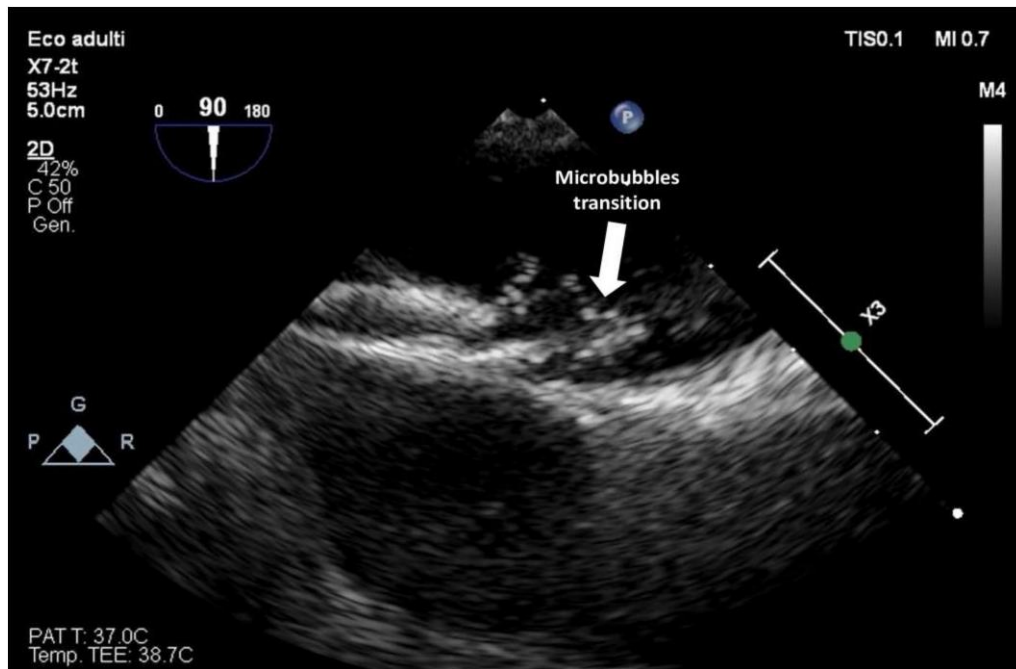
The procedure was performed under general anaesthesia with 2D/3D-TOE and fluoroscopic guidance (Figure 3, Supplementary material online, Videos S3 and S4). Using right femoral venous access, the orifice delimited by the native IAS and the Occluder was crossed with a Storq 0.035" steerable guidewire (Cordis, Santa Clara, CA, USA) and MP A1 5.2 Fr diagnostic catheter (Merit Medical Systems, South Jordan, UT, USA) (Figure 4, Supplementary material online, Video S5). Unfractionated heparin 6000 IU (80 UI/kg) was administered right before the crossing. Then, an Amplatzer Treviso 8 Fr (Abbott, Chicago, IL, USA) was advanced in the left atrium and an Amplatzer PFO Occluder 25 mm device was delivered in overlap with the previous one (Figure 5, Supplementary material online, Videos S6–S9). At the end of the procedure, the passage of the saline solution was abolished. No periprocedural complications occurred. The patient was discharged with dual antiplatelet therapy (DAPT: ASA 100 mg once daily + clopidogrel 75 mg once daily) for 1 month with the indication to continue afterwards only with ASA 100 mg once daily for 24 months. At the six-month follow-up visit, the patient had experienced no cerebrovascular events, no atrial arrhythmias, and no more migraine attacks in absence of any neurological therapy. The six-month follow-up trans-thoracic bubble echocardiogram confirmed that there was no residual right-to-left shunt (see Supplementary material online, Video S10).

## Discussion

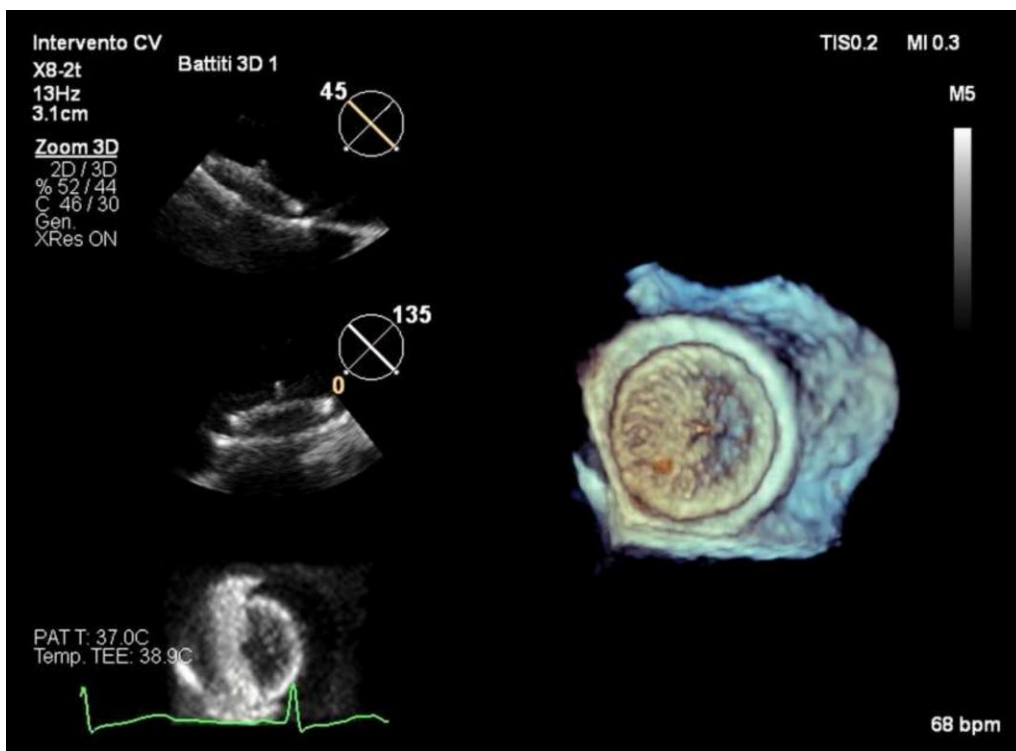
We present a peculiar case of a PFO closed ‘twice’ using two PFO Occluder devices. Transcatheter PFO closure is associated with



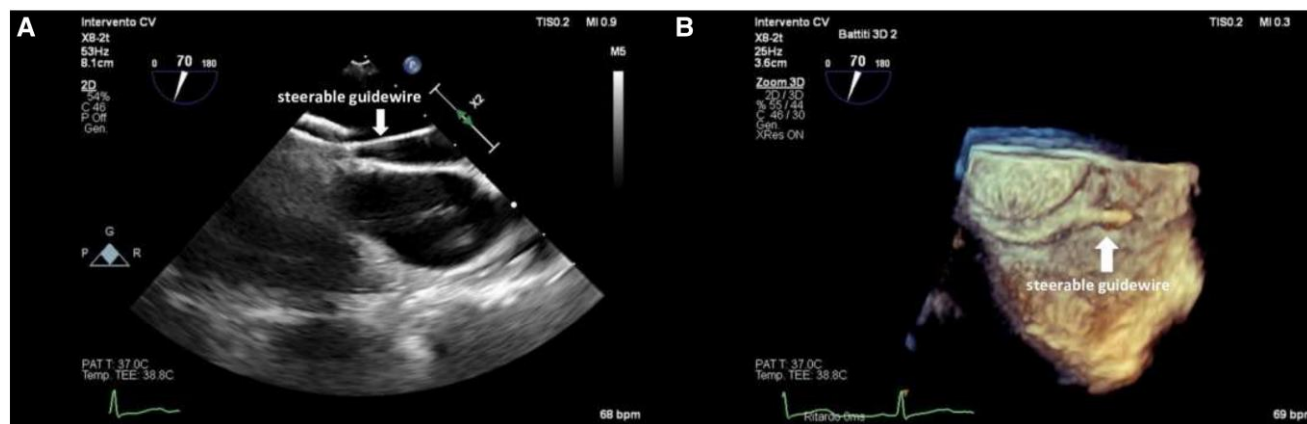
**Figure 1** Midesophageal bicaval view. Amplatzer PFO Occluder device partially displaced in the left atrium (white arrow).



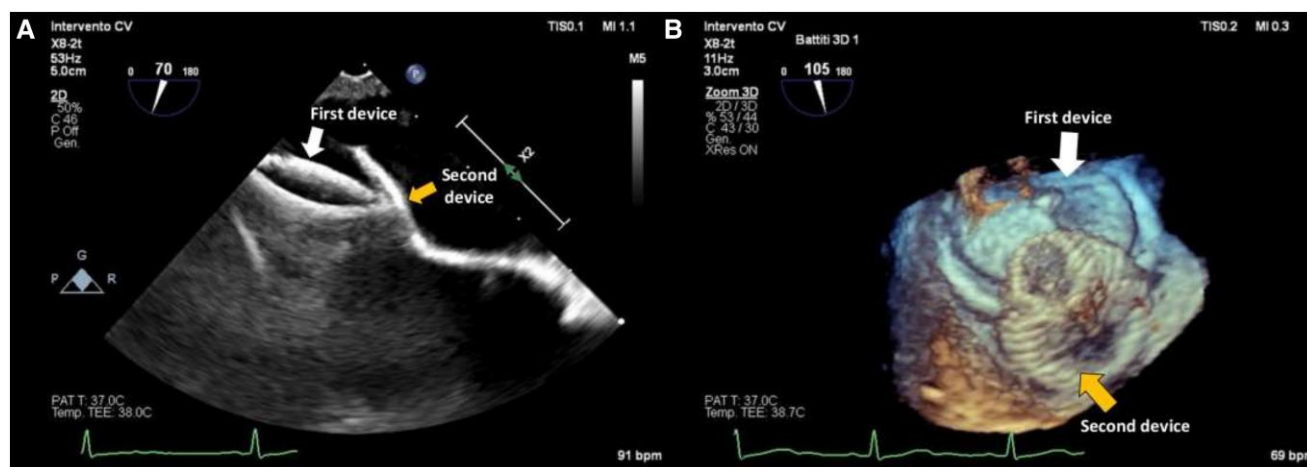
**Figure 2** Midesophageal bicaval view. Microbubbles transition from the right to the left atrium during the Valsalva manoeuvre (white arrow).



**Figure 3** 3D transoesophageal echocardiography. En face view (on the right) and MultiView (on the left) of the partially displaced Amplatzer PFO Occluder device.



**Figure 4** Midesophageal bicaval view (A) and 3D transoesophageal echocardiography (B). Steerq 0.035" steerable guidewire passing through the interatrial septum (white arrows).



**Figure 5** Midesophageal bicaval view (A) and 3D transoesophageal echocardiography (B). A second Amplatzer PFO Occluder device (yellow arrows) delivered in overlap with the previous one (white arrows).

significant improvement in migraine burden.<sup>6,9</sup> However, according to a recent metanalysis, residual IAS is seen in 93–96% of patients at 1-year FU after percutaneous closure procedure.<sup>10</sup> Residual IAS is associated with a four-fold increased risk of recurrent embolic events.<sup>11</sup> The case of our patient is almost unique, as there are limited reports of the aetiological role of residual IASs in persistent migraine attacks after percutaneous PFO closure. Interatrial shunt is known to increase the likelihood of migraine attacks, with persistent and larger PFO being associated to more frequent migraine symptoms.<sup>12</sup> However, the evidences on short- and long-term procedural results after repeated device implantation for a residual shunt are scarce, but encouraging.<sup>13,14</sup> In a single-centre experience of 21 percutaneous closures of residual moderate-to-severe IAS, the success rate, evaluated with the transcranial Doppler, was quite acceptable (76.2%) with no further cerebrovascular ischaemic accidents after a follow-up of  $41 \pm 19$  months.<sup>15</sup> The decrement of the paradoxical embolism phenomena, which is also

the main pathophysiological mechanism of PFO-associated migraine, may justify the neurological benefit of a second percutaneous procedure in the setting of relapsing migraine attacks linked to residual IAS. The inability to cross the residual orifice is the main limitation for a second occluder device implantation.<sup>15</sup> The case described highlights the utility of 3D-TOE in identifying residual IAS following PFO percutaneous closure and guiding its treatment through the position of a second PFO Occlusion device. Moreover, the possibility of a 'placebo effect' or the potential beneficial role of clopidogrel in reducing migraine symptoms in this specific case is limited by a clear fact: the patient remained stably asymptomatic after the effective closure of the residual IAS, even at the six-month FU visit with the DAPT (ASA + clopidogrel) interrupted only 1 month after the intervention.

Further studies on larger populations are necessary to elucidate the effective clinical benefit of a second percutaneous PFO closure in the long-term follow-up.

## Conclusion

A residual IAS should be suspected in patients with persistent migraine and a history of percutaneously closed PFO. The positioning of a second PFO occluder may be a potential beneficial strategy in selected patients with residual IAS and suitable anatomy for percutaneous management; however, further studies are needed in order to confirm our hypothesis. A Multidisciplinary Heart Team evaluation appears to be useful to tailor the management in this specific setting. Intraprocedural TOE is a fundamental technique to correctly guide the percutaneous closure of residual IASs.

## Lead author biography



October 2014–June 2020: medical school at the Vita-Salute San Raffaele University, Milan, Italy. December 2020–ongoing: Cardiology Residence at the Vita-Salute San Raffaele University, Milan, Italy.

## Supplementary material

[Supplementary material](#) is available at *European Heart Journal – Case Reports* online.

## Consent

The authors confirm that written consent for submission and publication has been obtained from the patient in line with the COPE guidelines.

*Conflict of interest.* None declared.

## Funding

None declared.

## Data availability

The data underlying this article are available in the article and in its online [supplementary material](#).

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