

A Complex Case of Percutaneous PFO Closure Complicated by Iatrogenic Pericardial Effusion and Successful Management with PDA Occluder

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Case Report

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Abstract

Patent foramen ovale (PFO) closure is increasingly performed for selected patients with cryptogenic stroke or migraine. However, complex anatomy such as long-tunnel PFO may increase procedural challenges and complication risks. We presented a patient who suffered from recurrent intermittent headache and dizziness for many years. Neurological and psychiatric evaluations, including cranial CT and MRI, were unremarkable. cTCD was positive for a right-to-left shunt (grade II, latent type), and TEE confirmed a long-tunnel PFO. During the attempted closure procedure, guidewire manipulation inadvertently perforated the fossa ovalis, entering the pericardial cavity. An 8 mm patent ductus arteriosus (PDA) occluder was then successfully deployed. At 6-month follow-up, the patient was asymptomatic; CT showed a stable occluder, and echocardiography revealed no interatrial shunt.

1. Introduction

The patent foramen ovale (PFO) is a normal physiological channel during fetal life that typically closes after birth; however, it remains patent in approximately 25–30% of adults¹. Although most individuals remain asymptomatic throughout their lives, accumulating evidence in recent years suggests a close pathophysiological relationship between PFO and migraine as well as other headache disorders^{2–5}. Right-to-left shunting may induce or exacerbate headache symptoms through mechanisms including paradoxical embolism, bypass of pulmonary metabolism of vasoactive substances, and cerebral microcirculatory disturbances. Multiple clinical studies consistently demonstrate that transcatheter PFO closure holds clear clinical potential for alleviating headache symptoms. Following the procedure, patients experience significant reductions in migraine frequency, duration, and disability^{6,7}.

The incidence of major procedural complications associated with transcatheter patent foramen ovale (PFO) closure is approximately 1–2.4%. The main complications include device embolization or migration, new-onset atrial fibrillation, residual shunt, device-related thrombosis, and rare delayed hypersensitivity or inflammatory reactions^{8–11}. This article reports the first case of iatrogenic cardiac perforation during PFO closure that was successfully managed through interventional means rather than cardiothoracic surgery.

2. Case summary

2.1 Case report

A 39-year-old female patient presented with recurrent episodes of intermittent headache and dizziness for many years. She had consulted multiple departments, including neurology and psychological medicine, where cranial CT and MRI revealed no organic abnormalities. Symptomatic treatment with analgesics provided little relief. She was subsequently referred to our department. A contrast-enhanced transcranial Doppler (bubble study) was positive (grade II, moderate shunt, latent type). Transesophageal

echocardiography revealed a complex patent foramen ovale (PFO) of the long-tunnel type. After a thorough discussion with the patient and her family, the decision was made to proceed with PFO closure.

2.2 Procedure Details

The right femoral vein was accessed, and 7000 units of heparin were given. A right heart catheter was advanced into the right atrium. Multiple attempts to pass a guidewire through the PFO failed. Right atrial angiography demonstrated two jets of right-to-left shunting at the fossa ovalis (Panel A, Video 1). Further attempts with a guidewire successfully crossed the fossa ovalis; however, based on the wire trajectory, it was suspected to have entered the pericardial cavity (Panel B, Video 2). A right heart catheter was advanced, and an RG3 guidewire together with a long guidewire was placed into the pericardial space. An 8F sheath was then advanced into the pericardial cavity. After removing the guidewire, gelatin sponge was injected through the sheath to seal the fossa ovalis. Post-procedural right atrial angiography showed a small residual shunt. Under fluoroscopy, an increase in pericardial effusion was observed, accompanied by a drop in blood pressure. Emergent subxiphoid pericardiocentesis and drainage were performed, yielding 320 mL of hemorrhagic fluid, 270 mL of which was reinfused via the femoral vein. A subsequent attempt was made to close the fossa ovalis using an atrial septal defect (ASD) occluder. The guidewire crossed the PFO into the pericardial cavity, followed by the right heart catheter. Attempts to use an ASD occluder failed to achieve adequate apposition of the right disc against the fossa ovalis (Panel C, Video 3). Subsequently, a patent ductus arteriosus (PDA) occluder (Shanghai Shape Memory Alloy Co., Ltd.; Shanghai, China) was attempted. The guidewire was crossed through the PFO into the pericardial space, the right heart catheter was advanced, and an 8 mm PDA occluder was delivered into the pericardial space via the delivery sheath. The sheath was withdrawn, and the occluder was pulled back to form the left disc. Continued traction successfully deployed the right disc. Angiography confirmed complete closure of the shunt (Panel D-E, Videos 4–5). No increase in pericardial effusion was noted on follow-up imaging. The delivery cable was rotated counterclockwise to release the occluder. The sheath was removed, local compression was applied, and the pericardial drain was secured. The patient was transferred to the coronary care unit for continued observation. No further increase in pericardial effusion was observed, and the pericardial drain was removed. The patient improved and was discharged.

2.3 Follow-up

The patient was prescribed regular oral aspirin and clopidogrel post-discharge. Follow-up at 1, 3, and 6 months showed resolution of symptoms. CT confirmed stable occluder position (Panel F-J). Echocardiography revealed no interatrial shunt signal. The patient remained asymptomatic.

3. Discussion

PFO-related right-to-left shunt is a known cause of cryptogenic stroke, migraine (particularly with aura), and platypnea-orthodeoxia syndrome¹². Percutaneous PFO closure using occluder devices is a well-established procedure with high technical success rates and low complication rates. Nevertheless,

device-related adverse events have been reported, including device-associated thrombosis, residual shunt, and arrhythmias. This case reports a rare complication of guidewire entry into the pericardial cavity during interventional closure of a long-tunnel type PFO, which was ultimately successfully closed using a PDA occluder.

Cardiac perforation is a serious complication of cardiac interventional procedures. Once it occurs, it can rapidly progress to cardiac tamponade and become life-threatening. According to available literature, cases of cardiac rupture following transseptal puncture for PFO closure have been reported¹³, but no perforation directly associated with PFO manipulation has been documented. In the present case, the guidewire successfully crossed the fossa ovalis after multiple attempts; however, its trajectory strongly suggested entry into the pericardial cavity, which was subsequently confirmed by angiography. The causes of perforation may include the following two aspects. First, anatomical factors. The patient had a long-tunnel type PFO with close apposition between the septum primum and septum secundum. During repeated advancement attempts, the guidewire was prone to deviate from the normal pathway and penetrate the thin region of the atrial septum (such as near the aortic root or the roof of the atrium), thereby entering the pericardial cavity. Second, procedural factors. An excessively stiff guidewire tip, excessive advancement force, lack of pressure monitoring, or failure to promptly recognize an abnormal wire trajectory may all increase the risk of perforation.

The most clinically instructive aspect of this case is that, with the guidewire having entered the pericardial cavity and a possible local perforation or abnormal channel in the atrial septum, conventional PFO occluders and ASD occluders—due to their short waist design—could not achieve effective trans-septal closure. We therefore attempted to use a PDA occluder and successfully closed the shunt.

The PDA occluder has a mushroom-shaped structure and was used innovatively in this case for trans-septal closure. The specific procedure was as follows: the left disc of the occluder was advanced into the pericardial cavity, followed by withdrawal of the delivery sheath and appropriate traction, allowing the left disc to adhere closely to the left atrial side of the atrial septum (i.e., the pericardial surface), while the right disc was positioned on the right atrial side. This achieved closure of the perforated PFO. Post-procedural angiography and follow-up confirmed no residual shunt, with satisfactory outcomes.

4. Conclusion

This case demonstrates the recognition and management of a rare complication—guidewire misplacement into the pericardial cavity during transcatheter closure of a long-tunnel type PFO. It also represents the first report of a successful rescue strategy using a PDA occluder to close the PFO after perforation. This case suggests that flexible adjustment of device selection may lead to successful outcomes in the setting of complex PFO anatomy or intraprocedural anomalies. This experience provides a reference for interventional cardiologists managing similar high-risk situations.

Abbreviations

PFO: Patent foramen ovale; PDA: Patent ductus arteriosus; ASD: atrial septal defect.

Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

Availability of data and materials: No datasets were analysed during the current study.

Competing Interests: The authors declare that they have no competing interests

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Authors' contributions: Ruchao Ma and Lin Pengyang were the primary surgeon, managed the patient, collected the data, and wrote the initial draft of the manuscript. Gang Chen, Guiqing Ma, Shu Liu and Ruixia Song assisted in the surgery, conducted the literature review, and prepared the figures. Lin Pengyang conceived the idea for the case report, provided critical supervision during the surgery, and critically reviewed and edited the manuscript for important intellectual content.

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References

1. Honasoge AP, Suradi HS, Tobis JM, Kavinsky CJ. Patent Foramen Ovale Closure for Nonstroke Indications. *J Soc Cardiovasc Angiogr Interv.* 2023;2:101135.
2. Li Y, Liu Y, Cao J, Shang Q, Zheng W, Li J, Shi X, Xin J, Zhao W, Meng Y, Li B, Luo X. White matter hyperintensity burden in young patent foramen ovale patients and its correlation with migraine. *Front Neurol.* 2025;16:1737566.
3. Tang Y, Sun H, Li Y, Li H, Yang R, Bosi D, Chen L. Altered cortical myelin and thickness in migraine patients with patent foramen ovale: A novel surface-based analysis. *Brain Imaging Behav.* 2025;19:865–73.
4. Tuerxun P, Liu J, Aisaiti A, Shen G, Gong P, Li X. Preliminary exploration of metabolomics mechanisms in patients with patent foramen ovale and migraine. *J Oral Facial Pain Headache.* 2024;38:111–21.
5. Stepanek J. The Contribution of Aerospace Medicine Specialty Expertise in the Diagnosis and Treatment of Headache Disorders with Concomitant Clinically Symptomatic Dyscapnia (Respiratory Alkalosis/Acidosis). *Curr Neurol Neurosci Rep.* 2025;25:72.
6. Li C, Lu Q, Zhang Y. Transcatheter Patent Foramen Ovale Closure and Complete Remission of Migraine in Children: A Single-Center Retrospective Cohort Study. *Pediatr Cardiol.* 2026.

7. Kong R, Yu J, Li J, Shi J, Xie Y, Wang S. Transcatheter closure of patent foramen ovale in children with migraine or dizziness. *Eur J Pediatr.* 2025;184:544.
8. Hamidani FN, Sievert H, Musallam M, Platschek L, Hohmann S, Berisha B. Late Embolization of a Patent Foramen Ovale Occluder Successfully Retrieved Percutaneously. *JACC Case Rep.* 2026;108472.
9. Cacciapuoti F, Rusciano E, Nasti R, Esposito M, Mauro C. Delayed Migration of an Amplatzer PFO Occluder to the Infrarenal Abdominal Aorta: Successful Endovascular Snare Retrieval. *Rep (MDPI).* 2026;9.
10. Spyropoulou P, Theofilis P, Mantzios PG, Tsatsaragkou A, Pantelidis P, Katsarou O, Tryfou E, Kalogeras K, Gialafos E, Siasos G, Oikonomou E, Vavouranakis E. Incidence of Atrial Fibrillation Post Patent Foramen Ovale (PFO) Closure: A Meta-analysis. *Curr Cardiol Rev.* 2026.
11. Li B, Zeng H, Xie H, Lan B, Zhang Y. Safety and efficacy of a novel biodegradable occluder- Pansy ® occluder compared with traditional nondegradable occluder in the closure of patent foramen ovale. *Front Cardiovasc Med.* 2026;13:1704287.
12. Kavinsky CJ, Szerlip M, Goldsweig AM, Amin Z, Boudoulas KD, Carroll JD, Coylewright M, Elmariah S, MacDonald LA, Shah AP, Spies C, Tobis JM, Messé SR, Senerth E, Falck-Ytter Y. Babatunde I and Morgan RL. SCAI Guidelines for the Management of Patent Foramen Ovale. *J Soc Cardiovasc Angiogr Interv.* 2022;1:100039.
13. Thompson AJ, Hagler DJ, Taggart NW. Transseptal puncture to facilitate device closure of long-tunnel patent foramen ovale. *Catheter Cardiovasc Interv.* 2015;85:1053–7.

Figures

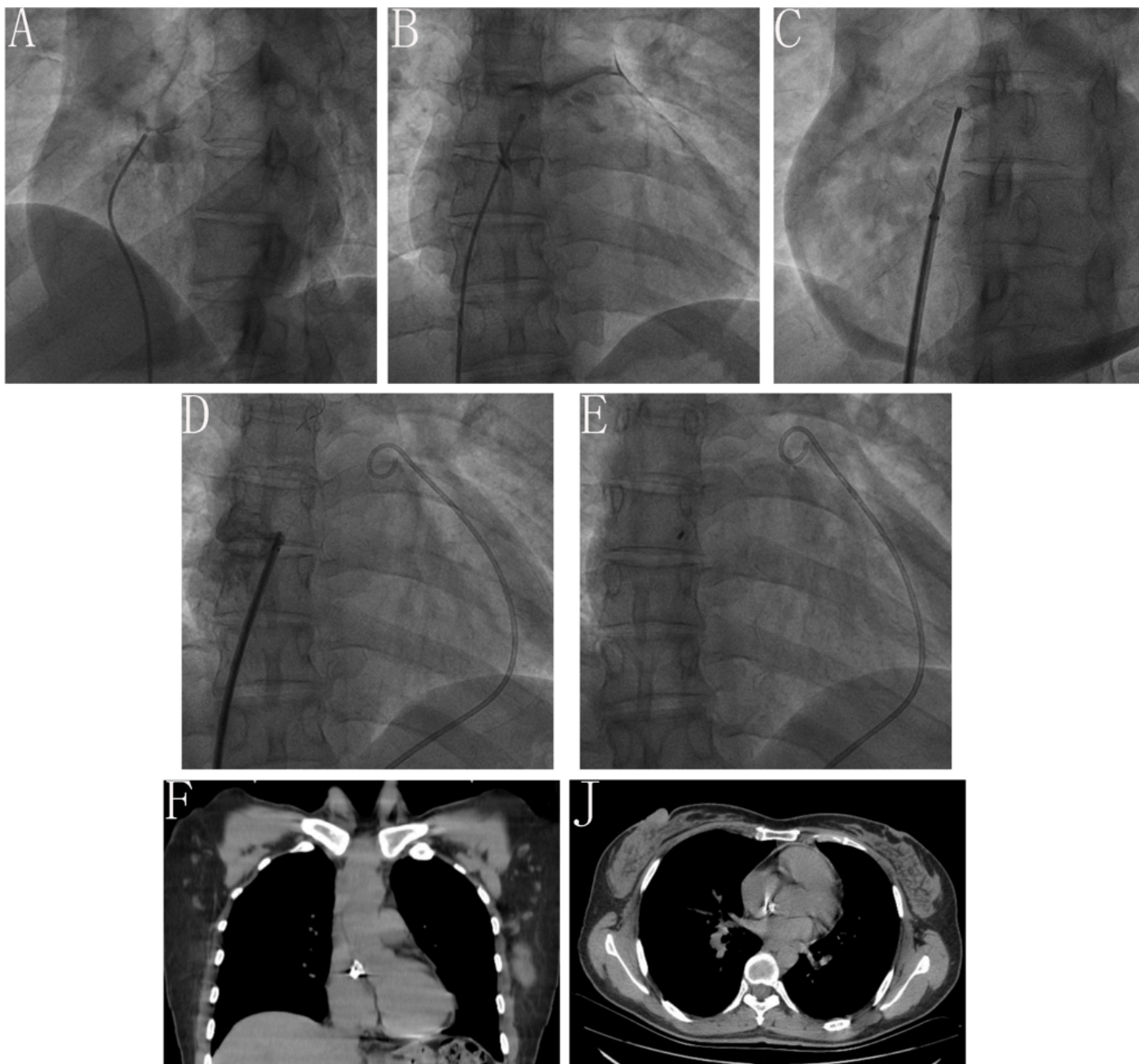


Figure 1

Legend not included with this version.

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