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# Challenging Diagnosis of Patent Foramen Ovale in Presence of a Large Eustachian Valve

Marouane Boukhris, Jean-Bernard Masson, Jeannot Potvin\*

Division of Cardiology, Centre Hospitalier de L'Université de Montréal (CHUM), Montréal, Québec, Canada

## Abstract

We report the case of a 39-year-old woman who presented with cryptogenic stroke. Conventional and contrast echocardiography modalities noticed a large Eustachian valve (EV) but failed to identify any right-to-left shunt. Conversely, contrast-transcranial Doppler revealed a grade 3 right-to-left shunt.

Contrast echocardiography was repeated with bubble injections through both an upper extremity and a femoral vein, 10 min apart from each other. While no shunt was observed following upper extremity injection, >20 bubbles crossed the inter-atrial septum when contrast was injected via femoral vein confirming the diagnosis of patent foramen ovale.

**Keywords:** PFO, Contrast echocardiography, Eustachian valve

## 1. Introduction

Patent foramen ovale (PFO) is observed in about 27% of normal healthy adults [1]. There is growing evidence that PFO is associated with cryptogenic stroke [1]. An Eustachian valve (EV) is an embryological remnant that directs the blood from the inferior vena cava to the area of the fossa ovalis and is present in up to 70% of patients with PFO [2]. However, the presence of a large EV could make challenging the identification and the quantification of right-to-left shunting through PFO.

## 2. Case report

We report the case of a 39-year-old woman on oral contraception who presented with sudden aphasia and loss of muscular control in right upper and lower extremities. No prior cerebrovascular accidents or cardiac problems were present in the patient's medical or family history.

Cerebral imaging modalities revealed thrombotic occlusion of the left middle cerebral artery. Thrombolysis and thrombectomy were performed with partial improvement of symptoms.

Transthoracic echocardiography (TTE) showed normal heart structure with preserved left ventricular ejection fraction and no intracardiac thrombus. Contrast TTE through an upper extremity vein did not reveal any atrial shunt. No atrial fibrillation was detected on holter recording nor was deep venous thrombosis found in lower extremity venous doppler.

Contrast-transcranial Doppler (c-TCD) revealed a grade 3 right-to-left shunt (>10 microemboli).

Nonetheless, conventional color Doppler and contrast transesophageal echocardiography (TEE) did not show any atrial shunting neither at rest nor following a Valsalva maneuver (Figs. 1 and 2). Importantly, a large Eustachian valve (EV) was noticed (Fig. 3).

We sought to demonstrate that the presence of a large EV could alter the accuracy of contrast echocardiography, particularly when injection is performed through upper extremity. Therefore,

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\* Corresponding author at: Centre Hospitalier de l'Université de Montréal, 1051, Sanguinet, Montréal, Québec, H2X3E4, Canada.  
E-mail address: [jeannotpotvin@hotmail.com](mailto:jeannotpotvin@hotmail.com) (J. Potvin).





Fig. 1. Contrast TEE showing no atrial shunt. The Eustachian valve (white arrow) keeps the microbubbles away from the septum. TEE = transesophageal echocardiography.

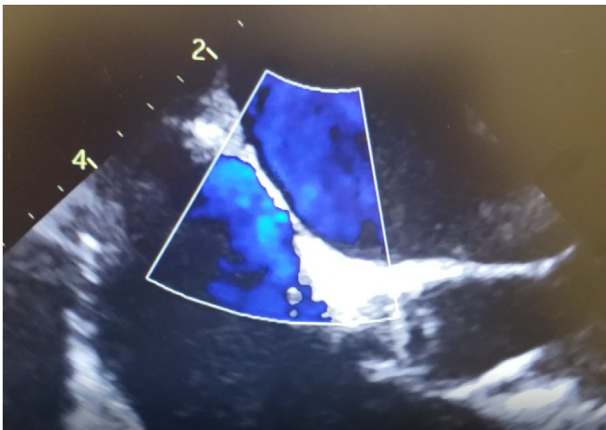


Fig. 2. Color Doppler TEE showing no atrial shunt. TEE = transesophageal echocardiography.

contrast TTE was repeated with injections through both an upper extremity and a femoral, 10 min apart from each other. While no contrast reached the area of the fossa ovalis and no shunt was observed



Fig. 3. Large Eustachian valve noticed on TEE (white arrow). TEE = transesophageal echocardiography.

following upper extremity injection (Fig. 4), >20 bubbles crossed the inter-atrial septum (IAS) after injection from the femoral vein (Fig. 5).

Hence, the diagnosis of patent foramen ovale (PFO) was made. Percutaneous closure was performed one month later with a 25 mm Amplatzer™ PFO Occluder (Abbott Vascular) under intracardiac echocardiography guidance (Fig. 6).

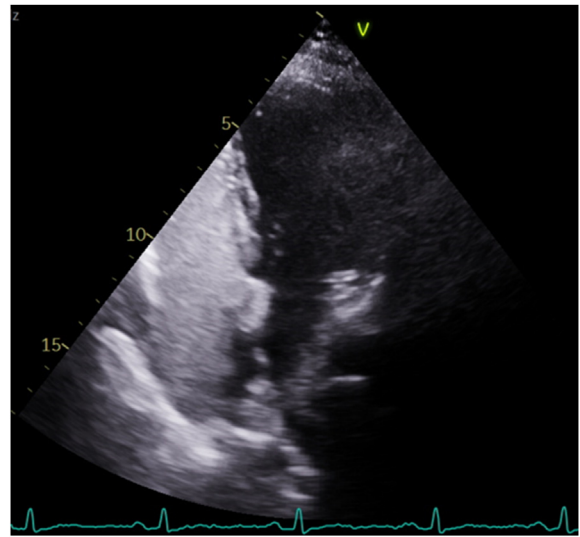


Fig. 4. Contrast TTE with injection through upper extremity vein. Contrast bubbles arriving from above (the arm) are kept away from the atrial septum by the Eustachian valve guiding the blood from below (IVC via femoral vein) directly onto the PFO and thereby monopolizing that area (black area to the left of the septum). TTE = transthoracic echocardiography.

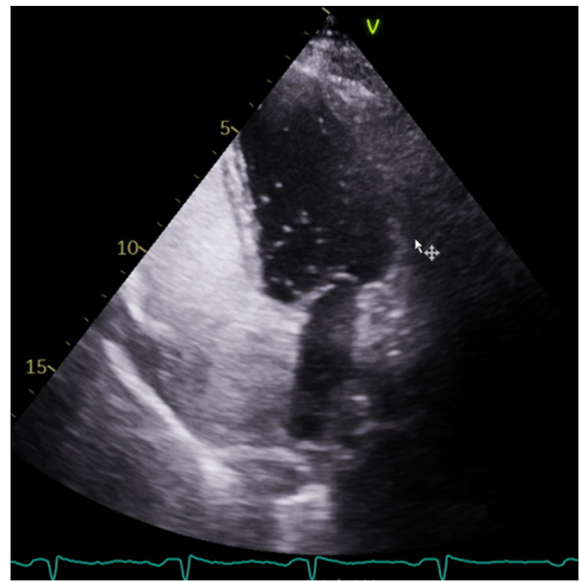


Fig. 5. Contrast TTE with injection through femoral vein: significant right-to-left shunt (>20 microbubbles). TTE = transthoracic echocardiography.

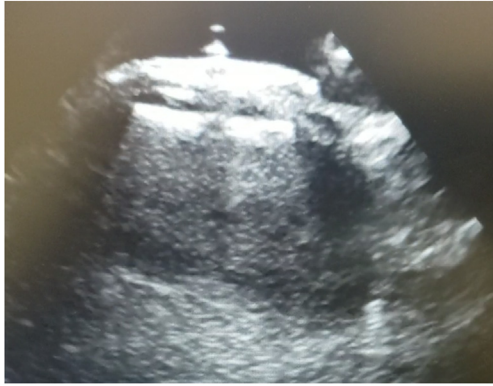


Fig. 6. Percutaneous closure of PFO under ICE guidance. ICE = intra-cardiac echocardiography; PFO = patent foramen ovale.

The patient followed a rehabilitation program. Dual anti-platelet anti-aggregation (aspirin and clopidogrel) was prescribed for 3 months and oral contraception was stopped permanently.

### 3. Discussion

Our case demonstrates that the presence of a large EV can compromise the ability of contrast echocardiography to detect or quantify right-to-left shunting when microbubbles are injected through the arm. Blood reaching the right atrium (RA) via the superior vena cava (SVC) interacts with the EV to follow a course that is unfavourable to PFO flap opening, as opposed to the preferential direction of blood travelling from the IVC. Indeed, contrast entering the RA via the SVC may never reach the PFO area.

Although, Schuchlenz et al. [3] claimed the superiority of color Doppler echocardiography over bubble injections in presence of large EV, this modality did not allow PFO detection in our case.

On the other hand, TCD during forced expiration into a manometer was demonstrated to be more sensitive than echocardiographic imaging for the detection of right-to-left shunts [4]. One explanation is the achievement of higher intrathoracic pressures and more efficient Valsalva maneuvers obtained when immediate feedback from a manometer guides the forced expiration during TCD [4]. Furthermore, the timing of the Valsalva maneuver is crucial. The PFO opens when the wave of lower body blood reaches the septum at the end of a sustained Valsalva maneuver. The microbubbles should arrive simultaneously with that wave to allow the detection of interatrial shunt. With

echocardiographic modalities, a significant portion (or all) of the shunting may be missed by the limited imaging plane, which can be even more difficult to stabilize during Valsalva.

### 4. Conclusion

In conclusion, when clinical evaluation suggests paradoxical embolization, visualization of a filling defect adjacent to the interatrial septum during TTE microbubble injections or direct TEE observation of a large EV should raise the possibility of PFO underdetection or shunt magnitude underestimation. In this particular scenario, a multi-modality diagnostic strategy should be considered using either TCD with manometer-guided forced expiration and/or echocardiography with contrast injection via lower extremity veins to best orient discussions about secondary prevention therapies.

### Author contribution

Conception and design of Study; Supervision of the research; Research coordination and management: Jeannot Potvin. Literature review; Acquisition of data; Analysis and interpretation of data; Research investigation and analysis; Data collection; Revising and editing the manuscript critically for important intellectual contents; Data preparation and presentation: Marouane Boukhris, Jean-Bernard Masson, Jeannot Potvin. Drafting of manuscript: Marouane Boukhris, Jeannot Potvin.

### Conflict of interest

None to declare.

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