Right-to-left shunt through patent foramen ovale during off-pump coronary artery bypass

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Off-pump coronary artery bypass (OPCAB) is widely performed to reduce the risk due to cardiopulmonary bypass. Lifting and stabilizing the heart to expose the target coronary artery often increase pressure in the pulmonary artery or right atrium, which can cause right-to-left shunt in patients with a patent foramen ovale (PFO).

A-59-year-old man presented with effort angina and 2-vessel disease, but no major comorbidity. His ejection fraction was 65%. OPCAB was scheduled. Transesophageal echocardiography (TEE) performed under anesthesia revealed a previously undetected PFO (Figure 1), but no shunt through it (Figure 2, A). As the heart was lifted for distal anastomosis of the right coronary artery, the blood oxygen saturation value (SpO₂) decreased from 99% to 86%, and mixed venous oxygen saturation remained at approximately 58%. There were no problems with the airway or ventilation. Right-to-left shunt through the PFO was revealed by TEE (Figures 2, B, and 3). The diameter of the PFO was 4.3 mm. The fraction of inspiratory oxygen (Fio₂) increased from 0.6 to 1.0, and SpO₂ increased to 92% in 5 minutes. No change in position was needed in completing anastomosis. The SpO₂ value recovered immediately after the heart was returned to the normal position in a further 8 minutes. The patient was discharged without complications.

Reports of right-to-left shunt through a PFO during OPCAB are rare,¹⁻⁴ and desaturation was reported in only 2 of these cases.^{1,2} Lifting of the heart to expose the diaphragmatic surface caused desaturation in both cases. When desaturation due to a PFO is detected, the Fio₂ should be increased. With a pure intracardiac shunt, improvement in oxygenation may not be seen. Initiating cardiopulmonary bypass may be considered if desaturation remains severe even after increasing Fio₂ to 1.0.

Color-flow Doppler showing a right-to-left shunt flow through PFO during heart lifting.

Central Message

PFO can cause desaturation due to right-to-left shunt during OPCAB.

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FIGURE 1. Mid-esophageal bicaval view shows previously undetected PFO with no shunt flow. TEE, Transesophageal echocardiography; IAS, Interatrial septum; RA, right atrium; LA, left atrium; MI, mechanical index; TIS, soft tissue thermal index.

OPCAB in patients with a PFO can cause desaturation. Intraoperative TEE may be useful in diagnosing the problem.

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FIGURE 2. Mid-esophageal bicaval view with color-flow Doppler. A, PFO with no shunt flow while the heart was in normal position. B, PFO with right-to-left shunt flow during heart lifting. *TEE*, Transesophageal echocardiography; *IAS*, Interatrial septum; *RA*, right atrium; *LA*, left atrium; *MI*, mechanical index; *TIS*, soft tissue thermal index.

FIGURE 3. A 3-dimensional TEE image of PFO. A, Systolic phase. B, Diastolic phase. PFO was enlarged during diastolic phase. *TEE*, Transesophageal echocardiography; *MI*, mechanical index; *TIS*, soft tissue thermal index.

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