

# Intraoperative hypoxemia and dynamic right-to-left shunting across a patent foramen ovale diagnosed by TEE

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## Abstract

The images presented highlight the degree of dynamic right-to-left shunt (RTLs) across a typical patent foramen ovale (PFO) that is possible with suboptimal changes in ventilation and oxygenation that may occur under anesthesia or in the intensive care setting. In this case, a large RTLs across a PFO contributed to significant persistent hypoxemia, and the echocardiography exam was necessary for diagnosis, aggressive treatment, and complete resolution of the pathology.

The transesophageal echocardiography (TEE) images in this report were taken from a patient without previous cardiopulmonary pathology undergoing orthopedic surgery under general anesthesia. The patient was noted to be significantly and persistently hypoxemic intraoperatively, leading to TEE probe insertion and examination. Image 1A depicts a large defect between the septum primum and septum secundum with evidence of significantly elevated right atrial pressure (RAP). The interatrial septum is bowed to the left, and color flow Doppler shows significant right-to-left shunt (RTLs) across the patent foramen ovale (PFO). In this case, lung recruitment maneuvers and increased controlled ventilation led to a gradual improvement in oxygen saturation as well as in the degree of RTLs. Image 1B was taken from the same patient near the end of surgery, and shows only a small, typical left-to-right shunt (LTRS) across the PFO after normalization of the RAP.

A PFO is present in 20-25% of the population<sup>1-2</sup>. When the normal pressure difference between the left and right atria is preserved, flow across the interatrial septum is typically limited to an intermittent LTRS. If the RAP becomes significantly higher than the left atrial pressure, there is potential for the opening to stretch and for significant RTLs to occur<sup>1</sup>. This may cause paradoxical embolism of air or thrombus, as well as hypoxemia from the flow of desaturated blood into the left atrium. Hypercarbia, hypoxemia, acidosis, and acute pulmonary embolism may increase right ventricular (RV) afterload acutely, creating a RTLs across a PFO and subsequent or worsened hypoxemia. When this pathology is identified by echocardiography, efforts should be made to decrease RAP by lowering RV afterload, correcting hypercarbia, hypoxemia, and acidosis, and supporting RV function. These images highlight the degree of dynamic shunting that can occur with changes in RV afterload over a short period of time, as well as the usefulness of intraoperative TEE to evaluate causes of persistent hypoxemia.

## References

1. Silvestry FE, Cohen MS, Armsby LB, et al. Guidelines for the echocardiographic assessment of atrial septal defect and patent foramen ovale: from the American Society of Echocardiography and Society for Cardiac Angiography and Interventions. *J. Am. Soc. Echocardiogr.* 2015;28(8):910-958. doi:10.1016/j.echo.2015.05.015.

