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Hypoxemia Due to Right-to-Left Shunting Through a Patent Foramen Ovale in a Postoperative ICU Patient: A Case Report

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Abstract:

Background: Hypoxemia in postoperative Intensive Care Unit (ICU) patients is often multifactorial, with common causes including atelectasis, pneumonia, or pulmonary embolism. However, right-to-left shunting through a Patent Foramen Ovale (PFO) is a rare but critical differential diagnosis in unexplained hypoxemia.

Case presentation: A 65-year-old male with a history of Chronic Obstructive Pulmonary Disease (COPD) was admitted to the ICU after colon cancer surgery. Preoperatively, he had no hypoxemia, but intraoperative hypoxemia developed and persisted postoperatively despite mechanical ventilation. Chest radiograph revealed mild bilateral lower lobe opacities. Given the suspicion of right-to-left shunting, a contrast echocardiography (Agitated Saline Contrast Echocardiography) was performed, which demonstrated a massive right-to-left shunt. The patient was extubated and transitioned to High-Flow Nasal Cannula (HFNC), resulting in improved oxygenation. Subsequent Transesophageal Echocardiography (TEE) confirmed a Patent Foramen Ovale (PFO) with a diameter of 6 mm. Oxygen support was gradually de-escalated to nasal cannula, and the patient was successfully discharged from the ICU.

Conclusion: This case highlights the importance of considering right-to-left shunting via PFO in postoperative patients with unexplained hypoxemia. Early diagnosis with contrast echocardiography and timely respiratory support adjustment can lead to favorable outcomes.

Keywords: Patent foramen ovale; Right-to-left shunt; Hypoxemia; Contrast echocardiography; Case report

Introduction

Postoperative hypoxemia is a common challenge in ICU settings, often attributed to pulmonary complications such as atelectasis, infection, or fluid overload [1,2]. However, when hypoxemia persists despite mechanical ventilation and optimal medical management, alternative mechanisms such as intracardiac shunting should be considered [3]. PFO is present in approximately 25% of the general population and may remain asymptomatic until increased right-sided pressures—due to mechanical ventilation, pulmonary hypertension, or positive pressure—provoke a right-to-left shunt [4,5]. We report a case of a 65-year-old male with unexplained postoperative hypoxemia ultimately attributed to a large PFO.

Case Presentation

Patient Information and Timeline

A 65-year-old male with a history of COPD was admitted to the ICU following elective colon cancer surgery. Preoperative oxygen saturation was normal. Intraoperatively, the patient developed hypoxemia requiring increased FiO_2. Postoperatively, despite mechanical ventilation, hypoxemia persisted. A chest radiograph showed mild bilateral lower lobe opacities. Given the clinical context, a right-to-left shunt was suspected.

Clinical Findings and Diagnostic Assessment

On ICU admission, the patient was sedated and mechanically ventilated. Arterial blood gas (ABG) revealed persistent hypoxemia with PaO_2/FiO_2 ratio < 200 despite optimal PEEP. Cardiovascular examination was unremarkable. Bedside transthoracic echocardiography with agitated saline contrast (Agitated Saline Contrast Echocardiography) revealed a massive right-to-left shunt at rest, suggesting an intracardiac communication.

Therapeutic Intervention

The patient was extubated and placed on HFNC at 50 L/min with FiO_2 0.6, resulting in improved oxygen saturation. Subsequent TEE confirmed a 6 mm PFO with spontaneous right-to-left shunting. No other structural abnormalities were noted. Oxygen support was gradually weaned to nasal cannula over the following days.

Follow-Up and Outcomes

The patient remained hemodynamically stable and was transferred to the general ward on day 4 post-surgery. A follow-up contrast echocardiography showed a significant reduction in the right-to-left shunt. No further hypoxemic episodes occurred. Long-term follow-up with cardiology was arranged for consideration of percutaneous PFO closure if symptoms recurred.

Discussion

This case illustrates a diagnostic challenge in a postoperative ICU patient with persistent hypoxemia unresponsive to conventional respiratory support. The presence of a PFO, combined with elevated right-sided pressures from mechanical ventilation and possible pulmonary comorbidities, likely precipitated the right-to-left shunt. Contrast echocardiography remains a simple, bedside tool for detecting intracardiac shunts [6,7]. In this case, it was instrumental in guiding clinical decision-making. Early extubation and transition to HFNC reduced intrathoracic pressure and improved oxygenation, avoiding unnecessary interventions. PFO is often overlooked in the ICU setting but should be considered in patients with unexplained hypoxemia, particularly when pulmonary causes are excluded [8,9]. While percutaneous closure is not routinely indicated in acute settings, it may be considered in recurrent or refractory cases [10].

Limitations

This is a single case report, and findings may not be generalizable. The diagnosis was made post hoc, and no invasive hemodynamic monitoring was performed. Long-term follow-up data are not yet available. The role of routine screening for PFO in high-risk surgical patients remains unclear.

Table 1: Timeline of clinical events and interventions.

Date	Event	Intervention	Outcome
Day 0	Colon cancer surgery	General anesthesia	Intraoperative hypoxemia
Day 1	Postoperative ICU admission	Mechanical ventilation	Persistent hypoxemia
Day 2	Chest X-ray: bilateral opacities	Supportive care	No improvement
Day 2	Agitated Saline Contrast Echocardiography	Detected massive right-to-left shunt	Diagnosis of shunt confirmed
Day 2	Extubation	High-flow nasal cannula	Oxygenation improved
Day 3	TEE performed	PFO confirmed (6 mm)	Gradual de-escalation to nasal cannula
Day 4	ICU discharge	Stable on nasal cannula	Successful transfer

Figure 1

Contrast echocardiography shows an early large right-to-left shunt in the subcostal four-chamber view. B. TEE revealing a PFO. C. TEE image showing the interatrial shunt through the PFO.

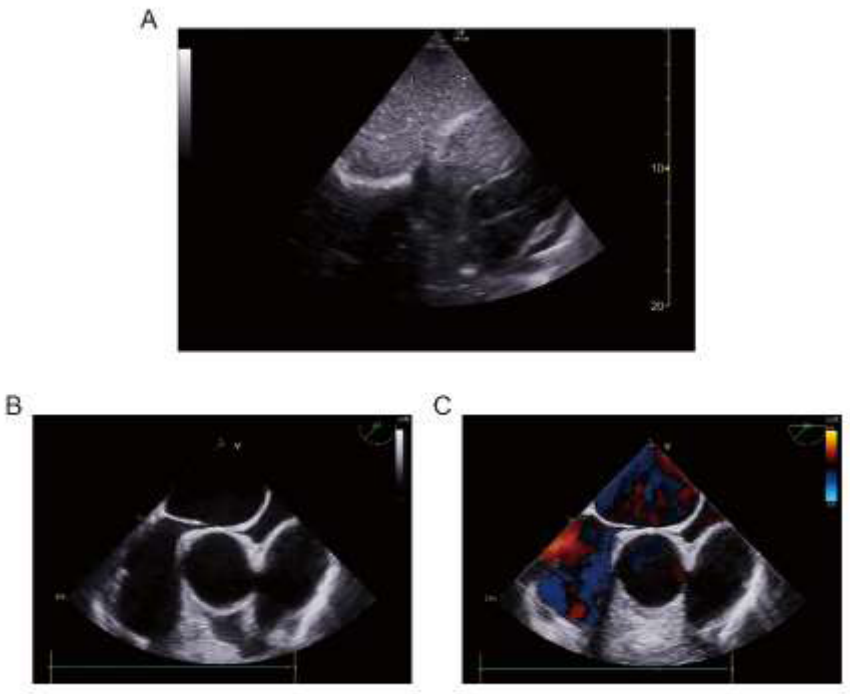
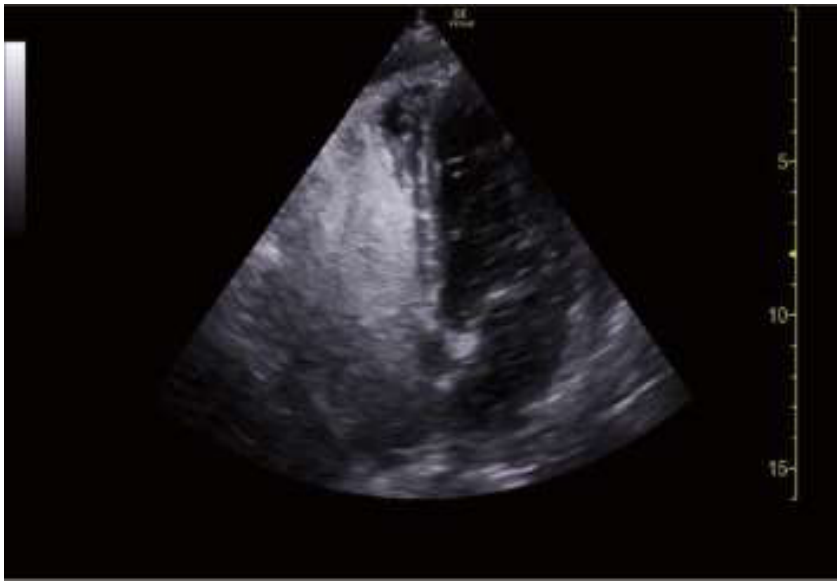


Figure 2

Contrast echocardiography (apical four-chamber view) demonstrating decreased early right-to-left shunting.



Conclusion

This case highlights the importance of considering right-to-left shunting through a PFO in postoperative ICU patients with unexplained hypoxemia. Early recognition with contrast echocardiography and appropriate respiratory support can lead to favorable outcomes. Further studies are needed to define the role of routine PFO screening in perioperative settings.

List of abbreviations

ICU	Intensive care unit
COPD	Chronic Obstructive Pulmonary Disease
HFNC	High-Flow Nasal Cannula
TEE	Transesophageal echocardiography
PFO	Patent Foramen Ovale
ABG	Arterial Blood Gas

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available

from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interest.

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Author's Contributions

Yulong Yao and Zhangjun Tan contributed equally to this work and should be considered the co-first authors.

Yulong Yao wrote the main manuscript text. Zhangjun Tan and Yuetian Yu were involved in patient management and data collection.

Yulong Yao and Zhangjun Tan performedthe data analysis and interpretation.

Yuetian Yu and Yuan Gao revised the manuscript critically.

Yulong Yao prepared the figures. All authors reviewed

and approved the final version of the manuscript.

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