

Background

Laparoscopic cholecystectomy is widely considered one of the safest surgical procedures in current medical practice⁽¹⁾. CO₂ embolism has been reported in multiple sources as a complication of laparoscopic cholecystectomy, but has thus far not been extensively studied in the setting of a robot-assisted cholecystectomy⁽¹⁻³⁾. The pneumoperitoneum generated by insufflation of the abdomen enables this to occur in both laparoscopic cholecystectomies and robot-assisted abdominal surgery, however robot-assisted cholecystectomy is often considered more precise due to heightened visual capability and precision tools that operate within the abdomen. Potential downstream consequences of CO₂ emboli in the perioperative setting include cerebral infarction leading to hemiplegia⁽¹⁾, cardiac arrest, and postoperative epileptiform seizure⁽⁴⁾. This case highlights the importance of perioperative vigilance in patients with extensive oncologic and surgical histories who may be predisposed to this complication. We hope this will highlight the key role of medical management and diagnostic imaging to prevent mortality as well as the role of abdominal pathologies in the development of CO₂ emboli. We also hope this will shed light on the need for all anesthesia providers to be educated in TEE so that a timely identification and correction of evolving CO₂ emboli can occur perioperatively.

Images

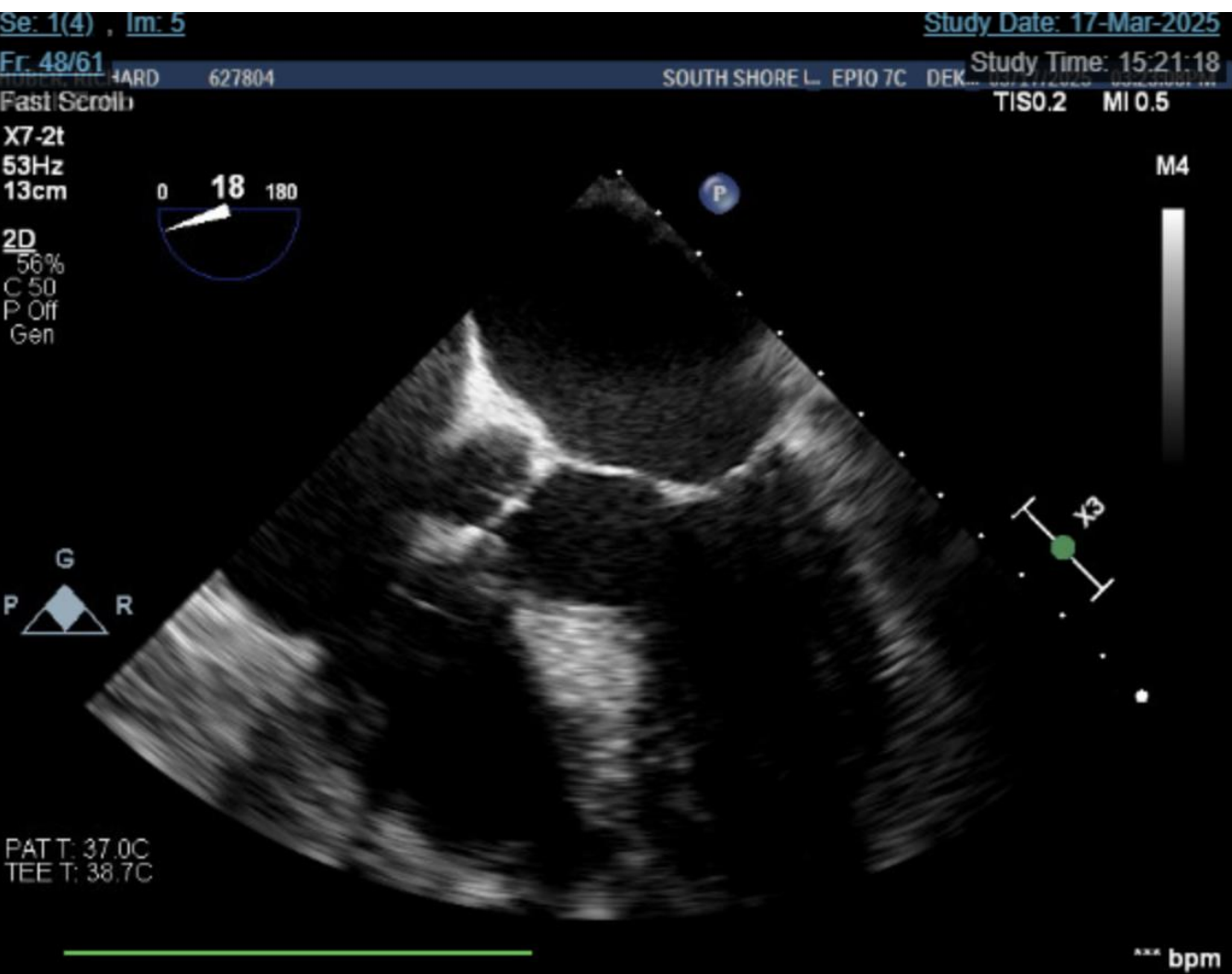


Figure 1. Intraoperative transesophageal echocardiogram showing no evidence of right heart strain.

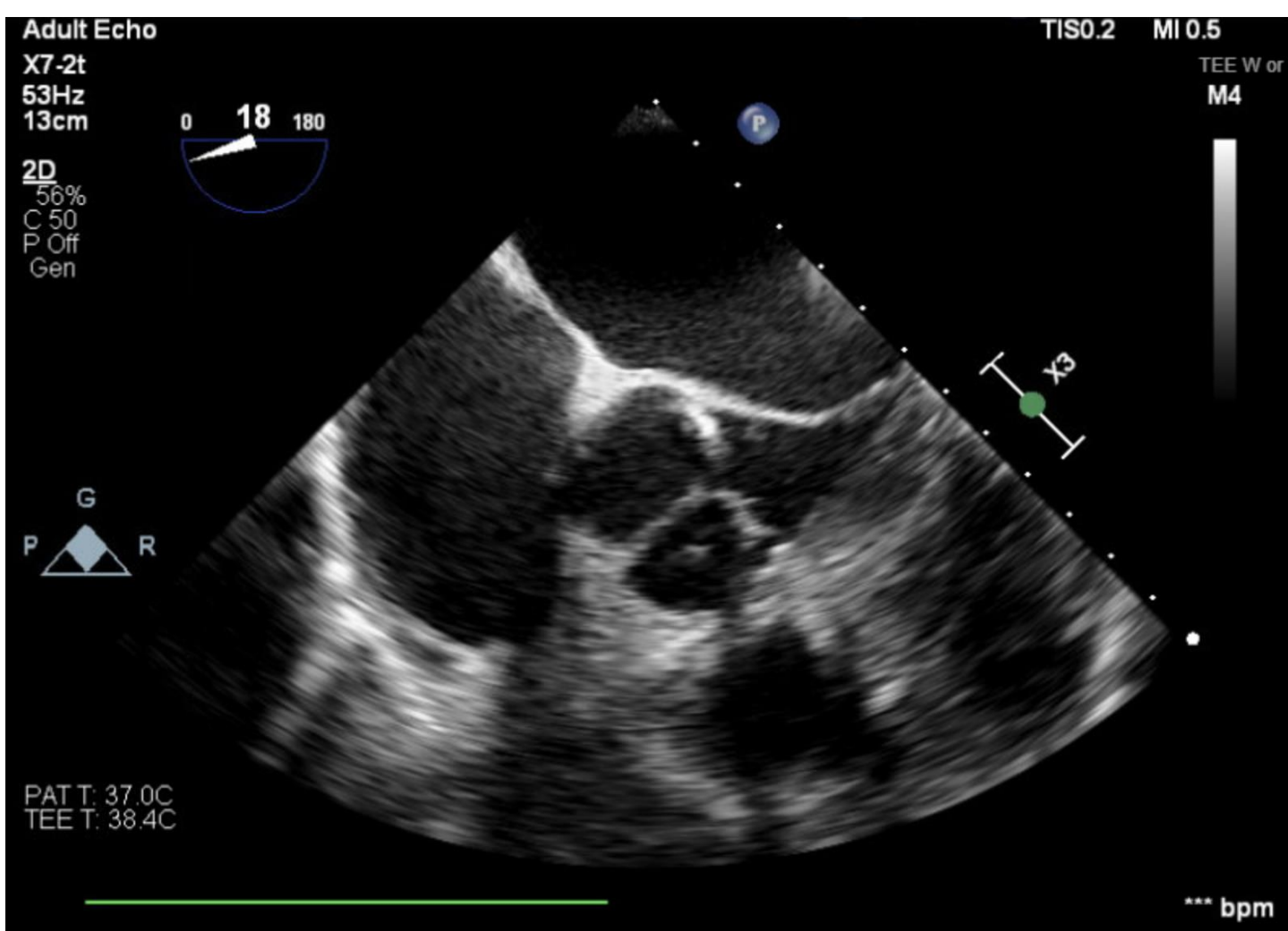


Figure 2. Intraoperative transesophageal echocardiogram showing aortic valve with mild aortic stenosis; no other abnormalities.

Case

A 70-year-old male with a past medical history of atrial fibrillation, type 2 diabetes, hypertension, hyperlipidemia, hypothyroidism, stable hepatocellular carcinoma treated with surgery and chemotherapy, presented to the emergency department with right upper quadrant pain, vomiting, and diarrhea of 1 day's duration. He underwent a computed tomography (CT) scan, which revealed a distended gallbladder with cholelithiasis and a stone impacted in the cystic duct—findings consistent with acute cholecystitis and an indication for cholecystectomy. The patient was placed on the schedule as an add-on procedure the following day for a robotic-assisted laparoscopic cholecystectomy.

Intraoperatively, what was described as abnormal omental adhesions above the liver were identified prior to visualizing the gallbladder. After a successful cholecystectomy, the surgeon then lysed adhesions near a friable omental mass in an attempt to send samples of the mass to pathology. It was during this excision of the mass in which a vascular injury in the hepatic territory occurred. While attempting hemostasis, the patient developed sudden hypotension to 80-90s/60-70s and a sharp rise in end-tidal CO₂ (EtCO₂) from 32 to 99 mmHg. This raised concern for CO₂ embolism. Anesthesia alerted the surgeon who then quickly controlled the bleeding. Insufflation ceased and simultaneously, a phenylephrine bolus was administered and his BP improved. The robot was undocked and the port sites were closed in the usual fashion. Prior to transporting the patient to the post-anesthesia care unit, transesophageal echocardiogram (TEE) was performed and showed no evidence of emboli or right heart strain (figures 1 and 2).

The patient experienced dyspnea on post-op day 1 which was investigated by CT scan that displayed multifocal pneumonia. He remained hemodynamically stable and was discharged on post-op day 4.

References

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Discussion

This case highlights the need for thorough preoperative assessment and intraoperative awareness of CO₂ embolism risk, especially in patients with prior hepatobiliary malignancy and surgical adhesions.

Monitoring:

TEE is the most sensitive modality for detecting CO₂ embolism. If unavailable, ET-CO₂ and transesophageal Doppler are viable alternatives. However, ET-CO₂ may show abrupt baseline changes and lacks sensitivity⁵. Transesophageal Doppler offers better sensitivity than ET-CO₂ and is more cost-effective than TEE, though evidence is limited to a porcine model (n=10)⁶.

Prevalence & Risk:

Evidence suggests all patients undergoing CO₂ insufflation experience some grade (I–IV) of embolism. While often subclinical, CO₂ embolism can become rapidly fatal if not recognized early.

Anesthetic Considerations:

In patients with liver pathology, including our patient with hepatic carcinoma, TIVA with propofol may reduce the duration of CO₂ embolism compared to sevoflurane⁷. This supports its use in high-risk surgical populations.

Management:

Immediate steps upon suspicion of hemodynamic compromise due to embolism include:

- Cease CO₂ insufflation
- Administer 100% O₂⁸
- Position patient in Trendelenburg to trap emboli in the right atrium⁹
- Use vasopressors to enhance emboli clearance through pulmonary circulation¹⁰
- Perform central venous gas aspiration in Trendelenburg⁵
- In extreme cases, employ cardiac massage or cardiopulmonary bypass¹¹

Future Directions:

We advocate for routine TEE training for anesthesiologists, as TEE enables real-time embolism detection and rapid intervention. Further research on transesophageal Doppler, as demonstrated by Mann et al.⁶, may offer a lower-cost yet effective alternative for embolism monitoring.

Significance:

While gas embolisms have been reported in laparoscopic cholecystectomies, hepatectomies, hysterectomies, and nephrectomies, only three cases have occurred during robot-assisted surgeries¹⁻³. This case is unique in reporting CO₂ embolism during a robot-assisted cholecystectomy, contributing novel insight to surgical and anesthetic practice.

Conclusion

Prompt recognition and management can prevent adverse outcomes. Perioperative closed loop communication between anesthesia providers and surgeons also plays a key role in swift correction of a potentially evolving CO₂ embolus. It is imperative that the anesthesiologist is vigilant during surgeries using CO₂ insufflation, particularly when the patient population has increased susceptibility due to past medical and surgical history. Additionally, to support patient safety, the anesthesiologist should feel empowered to voice any concerns during the time out, especially if there are unique considerations that would lead to unintended complications that warrant adhering strictly to the planned procedure.