Carbon Dioxide Venous Embolism During Retroperitoneoscopic Adrenalectomy

Kyle Yano DO; Haleh Saadat MD, FAAP ; Katherine Michelini MD
Department of Anesthesiology Quinnipiac University, CT

Introduction

Retroperitoneoscopic adrenalectomy (RPA) is increasingly favored for adrenal tumors (benign/malignant, functional/nonfunctional) due to:

- **Lower conversion rates** to open surgery
- **Reduced complications** vs. transperitoneal approaches
- **Shorter hospital stays**

Clinical Challenge

- RPA requires **high-pressure CO_2 insufflation** into the retroperitoneal space, posing risks:
  - **Hemodynamic instability**
  - **CO_2 absorption** → hypercapnia, acidosis
  - **Rare but life-threatening CO_2 embolism**

Case Focus

We present a **novel case of CO_2 embolism** during RPA, highlighting:

- **Intraoperative recognition** strategies
- **Critical management steps**

Patient Profile

Demographics:

- 73-year-old male, BMI 30 (obese)

Comorbidities:

- **CAD**: Non-obstructive coronary artery disease (stented RCA, 2019).
- **HFrEF**: Ejection fraction 40% (optimized on carvedilol, sacubitril/valsartan).
- **OSA**: Severe obstructive sleep apnea (CPAP-dependent, AHI 35).
- **DM2**: Insulin-dependent (HbA1c 8.2%), chronic kidney disease (Cr 1.8, eGFR 42).
- **Cushing's syndrome**: Secondary to cortisol-secreting adrenal adenoma (pre-op cortisol 28 µg/dL).

Preoperative Optimization:

- Cardiac clearance (stress test negative for ischemia).
- Bridged anticoagulation (held apixaban 48h pre-op).
- CPAP therapy continued perioperatively

Intra-Op Crisis

Timeline of Events:

1. **Baseline**:
   - $ETCO_2$: 35–40 mmHg
   - MAP: 92 mmHg | HR: 81 bpm | SpO_2: 99%
2. **CO_2 Insufflation**:
   - Retroperitoneal pressure: 25 mmHg (standard for RPA).
3. **Embolism Onset (10min post-insufflation)**:
   - **$ETCO_2$**: Sudden drop to 18 mmHg (Figure 1).
   - **Hemodynamics**: MAP ↓ to 60 mmHg, HR ↑ to 130 bpm.
   - **ABG**: pH 7.14, $PaCO_2$ 64 mmHg, HCO_3^- 18 mEq/L (severe acidosis).

Diagnostic Challenges:

- Initial suspicion of ventilator malfunction was ruled out via manual ABG.
- Differential diagnosis:
  - Pulmonary thromboembolism vs. hemorrhage

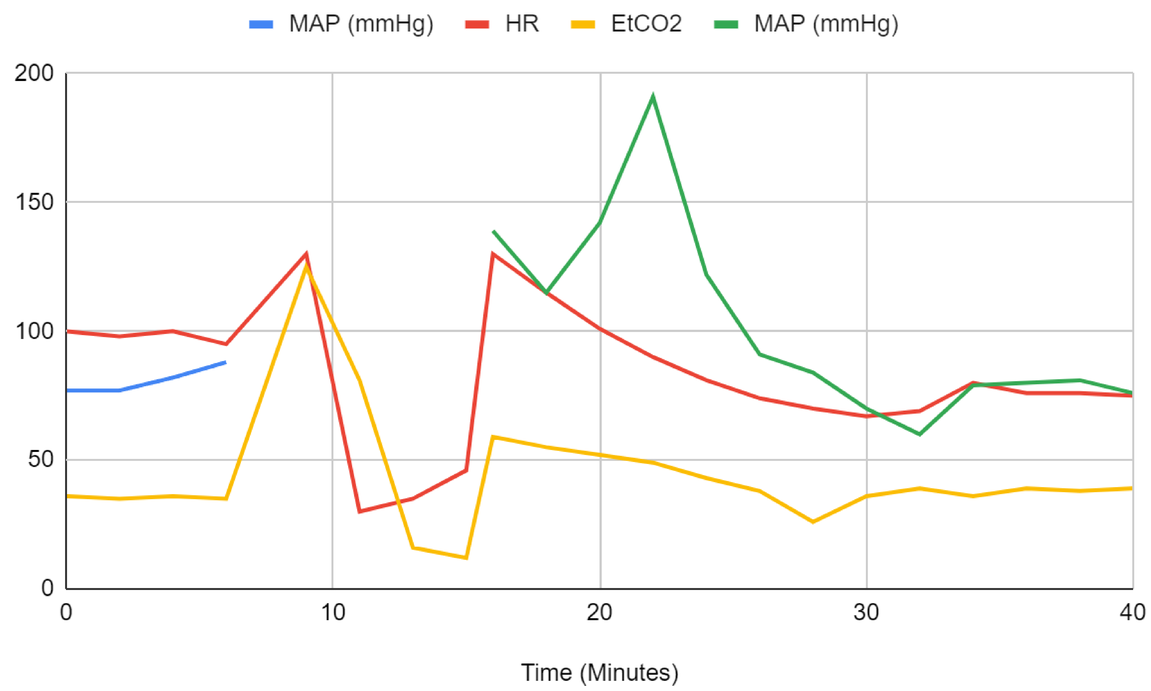

Figure 1. Trajectories of heart, mean arterial pressure and end-tidal CO2. MAP - mean arterial pressure measured both invasive (green) and non-invasive (blue); HR - heart rate' EtCO2 - end-tidal CO3

Immediate Interventions

1.Stop Insufflation: Retroperitoneal CO_2 pressure reduced to 0 mmHg

2.Repositioning: ; Prone → Left lateral decubitus (Durant maneuver) to trap gas in RV apex.

3.Pharmacologic Support:

- Phenylephrine boluses (100 µg ×3) → MAP stabilized at 85 mmHg.
- Sodium bicarbonate (50 mEq) → corrected pH to 7.32.
- Fluid resuscitation (1L LR) → improved preload.

4.Ventilation Adjustments:

- FiO_2 increased to 100% → SpO_2 100%.
- Minute ventilation ↑ (TV 600 → 800 mL) → normalized $PaCO_2$.

Intraoperative Monitoring:

Invasive BP (radial arterial line), TEE, serial ABGs (q15min).

Post-Crisis Stabilization:

•Hemodynamics normalized within 20min (MAP 85, HR 88, $ETCO_2$ 38 mmHg).

•Surgery resumed → successful right adrenalectomy (operative time: 2h 45min).

Postoperative Course:

•**PACU**: Extubated, no neurologic deficits (RASS 0, GCS 15).

•**Labs**: Cortisol ↓ to 5 µg/dL (post-resection), electrolytes normalized.

•**Discharge**: POD1 with CPAP, insulin regimen, and cardiology follow-up.

Long-Term Follow-Up: No residual embolism sequelae (6-week echo EF 45%, no RV dysfunction).

Outcome and Discussion

Carbon dioxide (CO_2) embolism is a rare but serious complication of videoendoscopic surgery, including retroperitoneoscopic adrenalectomy (RPA). While gas embolism is more commonly associated with procedures performed above heart level, it should always be considered in patients experiencing sudden hemodynamic instability during insufflation. A key distinction between progressive hypercarbia due to CO_2 absorption and a true gas embolism must be made. The former presents as a gradual rise in $PaCO_2$ without significant hypotension or oxygen desaturation, while a CO_2 embolism manifests as an acute and severe drop in arterial pressure, oxygen saturation, and pH, often with a rapid initial $EtCO_2$ spike followed by a sharp decline.

Early recognition and prompt management are essential to reduce morbidity and mortality. Treatment includes ventilation with 100% oxygen, left lateral positioning, cardiovascular support, and, if available, aspiration of gas through a central venous catheter. A multidisciplinary approach involving surgeons, anesthesiologists, and OR staff is critical for effective diagnosis and intervention.

References

1. . Al-Qurayshi Z, Robins R, Buell J, Kandil E. Surgeon volume impact on outcomes and cost of adrenal surgeries. Eur J Surg Oncol 2016; 42:1483.
2. Marrero AP, Kazaure HS, Thomas SM, et al. Patient selection and outcomes of laparoscopic transabdominal versus posterior retroperitoneal adrenalectomy among surgeons in the Collaborative Endocrine Surgery Quality Improvement Program (CESQIP). Surgery 2020; 167:250.
3. Abraham MA, Jose R, Paul MJ. Seesawing end-tidal carbon dioxide: portent of critical carbon dioxide embolism in retroperitoneoscopy. BMJ Case Reports, 2018: 2017219397.