



Anesthetic Management of Intracardiac Migration of an Endograft for Gunshot-Induced IVC Injury

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BACKGROUND

Objective: Highlight perioperative planning and multidisciplinary management of a traumatic IVC injury complicated by intracardiac graft migration.

Retrohepatic inferior vena cava (IVC) injuries are among the most lethal vascular traumas, with reported mortality rates exceeding **50–80%** due to massive hemorrhage and difficult surgical exposure.^{1,2} Endovascular stent-grafts allow rapid control of bleeding when open repair is not feasible, providing speed, minimal invasiveness, and reduced physiologic stress.³⁻⁵

However, their **off-label use in the IVC** introduces important limitations: risk of **thrombus formation, hepatic vein occlusion, and anatomic variability** that may predispose to **device migration or malposition**.^{6,7} From an anesthetic standpoint, retrohepatic IVC management requires aggressive **massive transfusion protocols (MTPs)**, anticipation of **coagulopathy and air embolism**, and readiness for rapid conversion between open and hybrid approaches.⁸

Successful outcomes depend on constant communication among **trauma, vascular, cardiothoracic, and anesthesia teams** throughout all procedural stages.

CASE CONTEXT

Conventional open repair is often unsuccessful in unstable patients due to limited exposure and massive bleeding. **Endovascular stent-grafting** has therefore emerged as a **damage-control alternative** that can achieve rapid venous hemostasis when time and access are constrained.³⁻⁵

This case highlights the **successful outcome achieved through close interdisciplinary coordination** and underscores the **pivotal role of anesthesiologists** in complex trauma settings—providing continuous perioperative management across evolving surgical stages and guiding definitive management.

Management required close **intradisciplinary coordination** between trauma, vascular, and cardiothoracic teams, while also considering patient-specific factors such as **age, physiology, and lifestyle**.

The **endovascular stent could not be removed** without risking disruption of the **fresh retrohepatic IVC injury** or precipitating **massive hemorrhage and bile leak**. Because the stent was not fully secured, there was a persistent **risk of thrombus formation** and potential **migration into the right atrium**. Management therefore focused on **hemodynamic stabilization, prevention of further stent migration, and anticoagulation balance**.

CASE DESCRIPTION

First Operation: An **18-year-old male** with no prior medical history sustained a **gunshot wound to the upper abdomen**, arriving in **hemorrhagic shock (SBP ≈ 60 mm Hg)**. **Massive transfusion protocol** was activated, and **exploratory laparotomy** revealed a **Grade IV liver injury (segments 2–4b)** with uncontrolled **retrohepatic venous bleeding**. Hemostasis attempts with compression, packing, Argon beam coagulation, and Pringle maneuver were unsuccessful. The patient received **10u PRBCs, 6u FFP, 1u platelets, and 3 L crystalloid**, requiring intermittent **phenylephrine boluses (700 µg total)**. The abdomen was **temporarily packed and closed with a Bogota bag**, and **CT angiography** confirmed a **retrohepatic IVC disruption (T11–T12)**. Patient was then returned to OR for second surgery.

Second operation: In the hybrid OR, **REBOA-PLUS** was inflated for aortic control. **Venography** localized the injury, and a **21 × 21 × 100 mm GORE cTAG** endograft was deployed with immediate hemostasis (**EBL ≈ 3.5 L**). During access, a **right-sided chest tube** released >3 L of blood from a retained hemothorax and 4u PRBCs was given. The patient stabilized post-deployment and was transferred to the SICU.

Third operation: Within 24 h, **CT** demonstrated **cephalad migration (~1.5 cm) into the right atrium**. TEE confirmed a **3-cm portion of the graft projecting** into the right atrium, parallel to the interatrial septum and approximately 2–3 mm from the tricuspid valve, without obstruction or valvular dysfunction. During re-exploration, the Bogota bag and eight lap pads were removed; the liver was hemostatic. A **28 × 28 × 100 mm cTAG** was overlapped 60 mm to **anchor the migrated stent**, restoring laminar caval flow. **Right-sided VATS** evacuated organized clot, and a new **32 Fr chest tube** was placed.

Interim ICU course: The patient remained stable on **low-dose heparin**, later transitioned to **enoxaparin and aspirin 325 mg daily**. Transaminases peaked (**AST 963 U/L, ALT 1433 U/L**) then normalized. Complications included a **bile leak** treated with **ERCP and intrahepatic stent placement** and a **transient GI bleed** managed endoscopically.

Fourth operation: After stabilization, **multidisciplinary discussion** with cardiothoracic surgery, cardiology, vascular surgery, and anesthesia led to **open heart surgery along with stent trimming and fixation**. Under general anesthesia with balanced volatile technique and **TEE guidance**, a **median sternotomy** and **bicaval cannulation** were performed. The stent was **trimmed with wire-cutting and Metzenbaum scissors** and **anchored with 4-0 polypropylene sutures** in four quadrants. Because complete IVC occlusion was not possible, **field flooding** made use of TEE valuable. The TEE enabled imaging of the stabilization position of stent with regards to vital structures, like coronary sinus, valves and interatrial septum .The patient was **weaned from CPB without inotropes**; post-CPB TEE showed **patent IVC, mild TR, and preserved function**.

Postoperative course: The patient was **extubated within hours**, transitioned to room air, and advanced to full activity. **Anticoagulation** was resumed per multidisciplinary protocol. He was **discharged home on postoperative day 7**, and **four-month follow-up imaging** confirmed a **patent retrohepatic IVC with stable graft position** and return to baseline activity without hepatic or cardiac sequelae.

CLINICAL IMPLICATIONS

Management of **retrohepatic IVC trauma** requires real-time coordination among **anesthesia, vascular, and cardiothoracic teams** to navigate rapid hemodynamic shifts and complex bleeding control.⁸ Anesthesiologists play a central role at every stage—**stabilizing physiology during exploratory laparotomy**, supporting **endovascular deployment**, and guiding **definitive cardiac repair** through intraoperative TEE imaging.

Intraoperatively, anesthesia management centers on vigilant **hemodynamic monitoring**, activation of the **massive transfusion protocol (MTP)**, and readiness for abrupt **preload and pressure changes** caused by IVC manipulation or balloon inflation. Continuous communication with the surgical team is essential to anticipate and prevent **arrhythmias, cardiac obstruction, or air embolism** near the heart and diaphragm.^{8,11}

Postoperatively, anesthesiology remains integral to ICU surveillance, anticoagulation management, and prevention of **thrombotic or pulmonary complications**. Additional vigilance is required for **hepatic dysfunction** from hepatic vein occlusion and **renal injury** from altered venous outflow.

This case also highlights the limitations of using **aortic-designed endografts in the venous system**, as differences in **radial force, vessel compliance, and venous hemodynamics** can lead to **device migration** into the right atrium or pulmonary artery.^{6,9,10} Such outcomes underscore the importance of **device selection tailored to venous physiology** and the **critical, longitudinal role of anesthesiology** in managing **hemodynamic, thrombotic, and coagulopathic risks** through resuscitation, procedural guidance, and postoperative care.

CONCLUSION

This case illustrates how anesthesiologists extend beyond airway and anesthetic delivery to function as **perioperative physicians** in complex endovascular trauma.

Through vigilant physiologic management and team coordination, anesthesiologists play a pivotal role in **optimizing outcomes and procedural success in high-risk endovascular trauma**.

REFERENCES

