JACC: CASE REPORTS VOL. 15, 2023


MINI-FOCUS ISSUE: STRUCTURAL HEART

INTERMEDIATE

CASE REPORT: CLINICAL CASE

# Obstruction of the Inferior Vena Cava Following Coronary Artery Bypass Grafting

Abdisamad M. Ibrahim, MD,[a] Bellony Nzemenoh, MD,[b] Ranjit John, MD,[c] Dante Dali, DO,[d] Jeremy Markowitz, MD,[a] Andrea Elliott, MD[a]

## ABSTRACT

Obstruction of the inferior vena cava (IVC) following coronary artery bypass grafting (CABG) is a rare complication. We describe a case of IVC outflow obstruction secondary to inferior cavoatrial junction injury during CABG. The diagnostic and management approaches used to care for this patient are discussed. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2023;15:101861) © 2023 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

## HISTORY OF PRESENTATION

A 65-year-old man with hypertension, type 2 diabetes, and coronary artery disease was admitted for an elective coronary artery bypass graft (CABG) at an outside hospital. His preoperative left ventricular ejection fraction (LVEF) was reported at 55% with inferior wall hypokinesis. CABG was performed with grafting of the left internal mammary artery (LIMA) to the left anterior descending artery and a saphenous vein graft (SVG) to the distal right coronary artery. The procedure was complicated by injury to the inferior cavoatrial junction, the site where the inferior vena cava (IVC) enters the right atrium of the heart, and severe blood loss requiring massive transfusion, followed by emergency repair of the cavoatrial junction with a pericardial patch while the patient was under hypothermic circulatory arrest. Despite aggressive volume resuscitation, as well as support with inotropic and pressor agents, attempts to wean the patient from cardiopulmonary bypass were unsuccessful. The patient was started on venoarterial (VA) extracorporeal membrane oxygenation (ECMO) through an ascending aorta arterial cannula and a left femoral vein venous cannula, an intra-aortic balloon pump was placed, and the patient's chest was left open because of continued

## LEARNING OBJECTIVES

- To describe the presentation of a patient with IVC obstruction.
- To recall the evaluation of a patient with IVC obstruction.
- To describe the appropriate diagnostic and management approach for a patient with postoperative IVC obstruction and thrombosis following CABG.

From the [a]Division of Cardiovascular Disease, Department of Medicine, University of Minnesota Medical School, Minneapolis, Minnesota, USA; [b]Department of Medicine, University of Minnesota Medical School, Minneapolis, Minnesota, USA; [c]Division of Cardiothoracic Surgery, Department of Surgery, University of Minnesota Medical School, Minneapolis, Minnesota, USA; and the [d]Division of Adult Cardiac and Minimally Invasive Robotic Thoracic Surgery, University of Missouri/Mercy Hospital, Springfield, Missouri, USA.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received March 17, 2023; revised manuscript received April 2, 2023, accepted April 7, 2023.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2023.101861

**ABBREVIATIONS AND ACRONYMS**

**CABG** = coronary artery bypass graft

**CCL** = cardiovascular catheterization laboratory

**CTA** = computed tomography angiography

**ECMO** = extracorporeal membrane oxygenation

**ECG** = electrocardiogram

**IVC** = inferior vena cava

**LIMA** = left internal mammary artery

**LVEF** = left ventricular ejection fraction

**OR** = operating room

**RV** = right ventricular

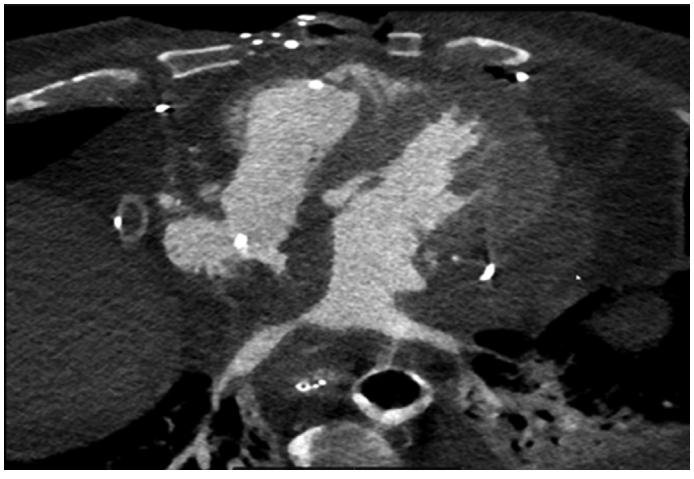
**SVG** = saphenous vein graft

**TEE** = transesophageal echocardiogram

**VA** = venoarterial

bleeding before transfer to our hospital. On postoperative day 3, the patient was receiving minimal vasopressor agents (epinephrine, at 0.02 μg/kg/min, and vasopressin, at 0.5 U/h). He underwent an attempt at decannulation in the operating room (OR). Flow on the ECMO circuit was decreased to 1 L/min. Shortly afterward, his vasopressor medication requirement increased (epinephrine [0.1 μg/kg/min], norepinephrine [0.2 μg/kg/min], and vasopressin [3 U/h],) and his lactic acid level rose from 0.8 mmol/L to 4.9 mmol/L. A transesophageal echocardiogram (TEE) at that time showed severely underfilled left and right ventricles. The decision was made to resume full ECMO support and return the patient to the intensive care unit. On postoperative day 6, the patient was weaned from all vasopressor agents. He subsequently returned to the OR for ECMO decannulation. While he was in the OR, ECMO flows were again turned down to 1 L/min, and hemodynamics were observed for approximately 30 minutes. His LVEF was estimated at 45%, and he had mild right ventricular (RV) dysfunction. His blood pressure and central venous pressure obtained from the right internal jugular vein pulmonary catheter remained stable. Therefore, the decision was made to proceed with ECMO decannulation, after which the patient was monitored in the OR for 2 hours. During this time, the patient had worsening hemodynamics requiring multiple vasopressor agents, a rapidly rising lactic acid level (1.1-14.1 mmol/L), and rising liver function tests. Thus, the patient's chest was left open, and he was recannulated on an emergency basis through peripheral VA ECMO (right femoral artery and right femoral vein) in the cardiovascular catheterization laboratory (CCL). During venous cannula insertion, there was atypical resistance passing the guidewire at the inferior cavoatrial junction from the femoral vein; therefore, the venous cannula was positioned above the hepatic veins but below the cavoatrial junction, as confirmed by angiography in the CCL.

**FIGURE 1** Computed Tomography Axial View of Obstructed Inferior Vena Cava



The right atrium is well opacified above the site of previous surgical repair. The right ventricle, pulmonary arteries, pulmonary veins, left-sided cardiac chambers, and the aorta are all well opacified.

## PAST MEDICAL HISTORY

The patient's past medical history included hypertension, type 2 diabetes, and coronary artery disease.

## DIFFERENTIAL DIAGNOSIS

The differential diagnosis for this patient's lack of successful weaning from VA ECMO support included postcardiotomy shock, myocardial infarction, right-sided heart failure, pericardial tamponade, cardiogenic shock, IVC thrombus, and IVC obstruction from repair of the cavoatrial junction injury.

## INVESTIGATIONS

The electrocardiogram showed sinus rhythm with a nonspecific ST-T wave abnormality, a ventricular rate of 96 beats/min, and a QTc interval of 477 ms. A coronary angiogram showed patent grafts (LIMA and SVG). Because the patient's chest was open, TEE was completed and showed LVEF of 25% to 30% and moderately to severely reduced RV function. The IVC could not be well visualized. There was echo-dense material adjacent to the right atrium in the expected location of the IVC-right atrium junction that was concerning for possible thrombus. At the time of the TEE, the patient was receiving norepinephrine (0.04 μg/kg/min) and vasopressin (2 U/h). ECG-gated computed tomography angiography (CTA) was performed with excellent contrast opacification of the right atrium; despite continuous ECMO flow at 0.5 L/min and multiple imaging phases, no contrast material was seen in the IVC, thus confirming IVC occlusion at the level of the surgical repair (**Figures 1 to 3**).

## MANAGEMENT

The patient was taken back to the OR for planned repair of the cavoatrial junction stenosis/occlusion.

Cardioplmonary bypass was initiated through the aorta, as well as superior vena cava and femoral vein cannulation. In the OR, the IVC was noted to be completely occluded by the surgical patch (**Figure 4**) from the cavoatrial junction to the diaphragm, mostly because of multiple repair sutures placed in this area to achieve surgical hemostasis. A portion of the diaphragm was divided to expose the infradiaphragmatic portion of the IVC. The previously attempted repair was carefully taken down, and the IVC and cavoatrial region were repaired with an 8 × 14 cm PhotoFix bovine patch. Postoperatively, the patient continued to be on ECMO to ensure postoperative stability, to resolve vasoplegia, and to allow for a longer ECMO weaning period because of the long duration of his support. Three days after the repair, he was successfully decannulated. As a result of the prolonged intubation, the patient underwent tracheostomy and was discharged to a long-term acute care hospital.

## FOLLOW-UP

A follow-up echocardiogram a month after discharge showed normal global and regional left ventricular function, with an LVEF of 55% to 60%, with normal RV size and function.

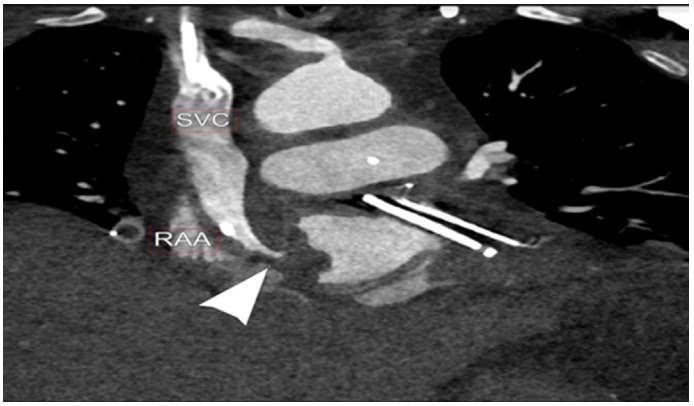
## DISCUSSION

CABG is the most common cardiac procedure performed worldwide. In the United States, approximately 200,000 cases are performed annually.[1] CABG is recommended for patients with obstructive coronary artery disease who will have a mortality benefit when compared with percutaneous coronary intervention or medical therapy. The mortality benefit of CABG has been thought to result from revascularization and protection against new infarction.[2]

The major complications of CABG include death, myocardial infarction, shock, acute kidney injury, bleeding, infection, stroke, and prolonged requirement of mechanical ventilation. IVC injury from CABG is very rare and has not been well described. IVC injury is usually seen in patients undergoing reoperative cardiac procedures or congenital surgery.[3]

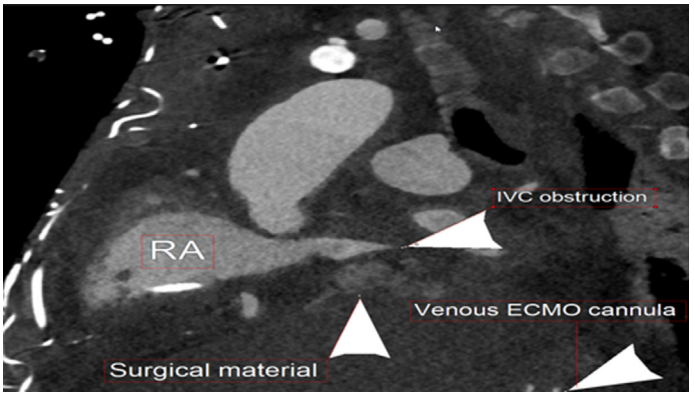
There have been a few case reports of IVC obstruction after surgical atrial septal defect repairs.[4] In those cases, the eustachian valve was mistakenly sutured to the interatrial septum, thus causing obstruction between the IVC and the right atrium.[4] Those patients required surgical excision of the eustachian valve to restore the connection between the IVC and the right atrium. Trauma to the IVC accounts for approximately 25% of abdominal vascular injuries obtained by trauma patients and has a mortality rate of 92%.[5] Approximately 50% of patients with IVC injuries die before making it to the hospital, and the mortality rate of those patients who receive medical care is approximately 20% to 57%.[6] IVC obstruction by thrombosis can develop as a sequela of

**FIGURE 2 Computed Tomography Coronal View of Obstructed Inferior Vena Cava**



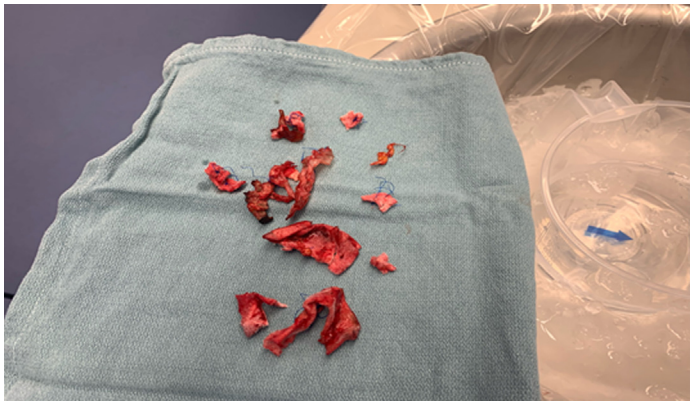

Single widely patent superior vena cava (SVC), which drains normally into the right atrium. The venous extracorporeal membrane oxygenation cannula is positioned deep in the intrahepatic inferior vena cava. Despite continuous flow through the extracorporeal membrane oxygenation circuit throughout the study, no contrast material is seen moving toward or entering the extracorporeal membrane oxygenation cannula at any phase of image acquisition. RAA = right atrial appendage.

**FIGURE 3 Computed Tomography Sagittal View of Obstructed IVC With Venous ECMO Cannula**




Surgical material is seen at the junction of the inferior vena cava (IVC) and the right atrium (RA). Despite multiple image acquisitions and continuous flow through the extracorporeal membrane oxygenation (ECMO) circuit throughout the study, no contrast material is seen at or below the level of the surgical repair, a finding consistent with occlusion at this level.

**FIGURE 4** Remnants of Pericardial Patch That Caused Inferior Vena Cava Obstruction



trauma and portends a high morbidity.[7] This trauma to the IVC has been described as occurring during cannulation of the femoral vein or during cardiopulmonary bypass, but it has not before been described as the result of patch repair of an iatrogenic injury to the IVC.[5,6] IVC syndrome is identified by signs that are secondary to obstruction of the IVC and inhibit venous return to the right atrium, as seen in the case of our patient.[6] In our patient, the initial repair led to nearly complete occlusion of the IVC that resulted in decreased venous return to the right atrium and decreased preload to the right and left ventricles, which in turn led to lower cardiac output, hypotension, and tachycardia. Because blood return to the right atrium was decreased, this resulted in hepatic congestion causing elevated liver function tests results, ascites, lower extremity edema, hypoxia, and a rapidly rising lactate level.

In our patient, the IVC was sutured with the pericardial patch (Figure 4) after an attempted repair of the inferior cavoatrial junction injury during his CABG procedure. The patient required surgical repair before mechanical support (VA ECMO) could be discontinued.

## CONCLUSIONS

This case highlights the utility of multimodality cardiac imaging using echocardiography and CTA for accurate diagnosis of postoperative complications of CABG. Early and prompt diagnostic evaluation and intervention resulted in a good outcome for this patient.

## FUNDING SUPPORT AND AUTHOR DISCLOSURES

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

**ADDRESS FOR CORRESPONDENCE:** Dr Abdisamad M Ibrahim, Division of Cardiovascular Disease, Department of Medicine, University of Minnesota Medical School, 420 Delaware Street SE, Minneapolis, Minnesota 55455, USA. E-mail: aibrahim0912@gmail.com.

## REFERENCES

**1.** Montrief T, Koyfman A, Long B. Coronary artery bypass graft surgery complications: a review for emergency clinicians. *Am J Emerg Med*. 2018;36(12):2289-2297.

**2.** Doenst T, Haverich A, Serruys P, et al. PCI and CABG for treating stable coronary artery disease: JACC review topic of the week. *J Am Coll Cardiol*. 2019;73(8):964-976.

**3.** Narayan P, Das D, Saha A, Das M. Successful repair of iatrogenic inferior vena cava injury during cardiac surgery. *Perfusion*. 2015;30(2):166-168.

**4.** Patel P, Lee A, Zaid J, et al. Inferior vena cava obstruction following surgical repair of a secundum atrial septal defect. *J Am Coll Cardiol Case Rep*. 2021;3(1):82-86.

**5.** Buckman RF, Pathak AS, Badellino MM, et al. Injuries of the inferior vena cava. *Surg Clin North Am*. 2001;81:1431-1447.

**6.** Heldenberg E, Hebron D, Kessel B, et al. Venous chimney procedure: a novel technical solution to prevent iatrogenic Budd-Chiari syndrome following retrohepatic vena cava injury. *J Endovasc Resusc Trauma Manag*. 2021;4(2):15-20.

**7.** Hollingsworth CM, Mead T. *Inferior Vena Caval Thrombosis. StatPearls [Internet]*. StatPearls Publishing; 2022. PMID: 30725860.

**KEY WORDS** cardiogenic shock, ECMO, IVC outflow obstruction, IVC thrombus