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CASE REPORT

ADVANCED

CLINICAL CASE

Coronary Dissection and Right Heart Failure Salvaged by PCI With Percutaneous Intraluminal Microaxial RV-Assist Support

Frans J. Beerkens, MD,[a] David Power, MD,[b] Victor Razuk, MD,[a] Nikola Kocovic, MD,[a] Ali Omar, MD,[c] Tafadzwa Mtisi, MD,[a] Gregory Serrao, MD,[b] Sahil Khera, MD,[b] George Dangas, MD, PhD[b]

ABSTRACT

Right heart failure is a dreaded sequelae of proximal right coronary artery occlusion that can complicate an angiogram or percutaneous coronary intervention. This case illustrates the use of a percutaneous intraluminal microaxial right ventricular assist device for high-risk percutaneous coronary intervention of an ostial right coronary artery dissection in refractory right heart failure. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2021;3:1612–1616)

HISTORY OF PRESENTATION

A 66-year-old woman presented to an outside hospital with acute-onset chest pain radiating to the jaw and down both arms. She had associated nausea but no shortness of breath or palpitations. She had no significant family history of sudden cardiac death, myocardial infarction (MI), or heart failure.

Her vital signs were: blood pressure, 105/65 mm Hg; heart rate, 70 beats/min; respiratory rate, 18 breaths/min; temperature, 98.6 °F; and oxygen saturation of 96% (on room air). On physical examination, the patient appeared in distress, although she had clear breath sounds bilaterally, a regular heart rhythm without any murmurs, no peripheral edema, and warm extremities.

LEARNING OBJECTIVES

- To understand the management of acute RHF and recognize the role of advance techniques when performing HR-PCI.
- To illustrate the expanding role of a percutaneous intraluminal microaxial RV assist device for RHF in carefully selected patients.

PAST MEDICAL HISTORY

The patient's previous known medical history included hypertension, hyperlipidemia, and obesity with a body mass index of 40 kg/m^2. She was a long-term smoker.

From the [a]Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, New York, USA; [b]The Zena and Michael A. Weiner Cardiovascular Institute, Icahn School of Medicine at Mount Sinai, New York, New York, USA; and the [c]Department of Medicine, Mount Sinai Beth Israel, New York, New York, USA.
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DIFFERENTIAL DIAGNOSIS

The differential for acute-onset chest pain includes MI, aortic dissection, pulmonary embolism, spontaneous pneumothorax, and musculoskeletal chest pain.

INVESTIGATIONS

Laboratory evaluation was significant for mildly elevated troponin enzymes of 0.05 ng/mL; however, surface electrocardiogram had ST-segment elevations in leads II, III, and aVF (**Figure 1**). Right-sided leads showed ST-segment elevations in V4R consistent with right ventricular (RV) MI. She was immediately taken for a coronary angiography, which, apart from a nonobstructive left coronary system, revealed a 99% mid right coronary artery (RCA) stenosis in a tortuous vessel with high anterior take-off from the aorta. Percutaneous coronary intervention (PCI) was unsuccessful and complicated by an iatrogenic proximal RCA dissection (Video 1), and thrombosis was noted during attempts to recannulate the true lumen. The patient was intubated and sedated. An intra-aortic balloon pump (IABP) was inserted for augmentation of coronary arterial flow. The patient was then transferred to our tertiary care hospital for further invasive management.

Upon arrival, the patient's troponin enzyme levels were elevated to 73 ng/mL, and she was transferred to the coronary care unit. A transthoracic echocardiogram revealed a left ventricular ejection fraction of 50% with focal inferior wall motion abnormalities, severe RV dysfunction, and mild RV dilatation. A pulmonary artery catheter was then inserted, which illustrated cardiogenic shock (**Table 1**), driven by right heart failure (RHF) in the setting of an RCA MI complicated by major proximal dissection.

MANAGEMENT

Intravenous cangrelor (4 mg/kg/min) and heparin were initiated in the coronary care unit to prevent further RCA thrombosis before intervention, elected over oral agents, given that cardiogenic shock would impair enteric drug absorption. Despite a trial of fluid resuscitation, medical therapy with dobutamine and inhaled nitrous oxide, as well as IABP support, the patient continued to decompensate, requiring additional norepinephrine and vasopressin. Due to body

ABBREVIATIONS AND ACRONYMS

HR-PCI = high risk-percutaneous coronary intervention

IABP = intra-aortic balloon pump

MCS = mechanical circulatory support

MI = myocardial infarction

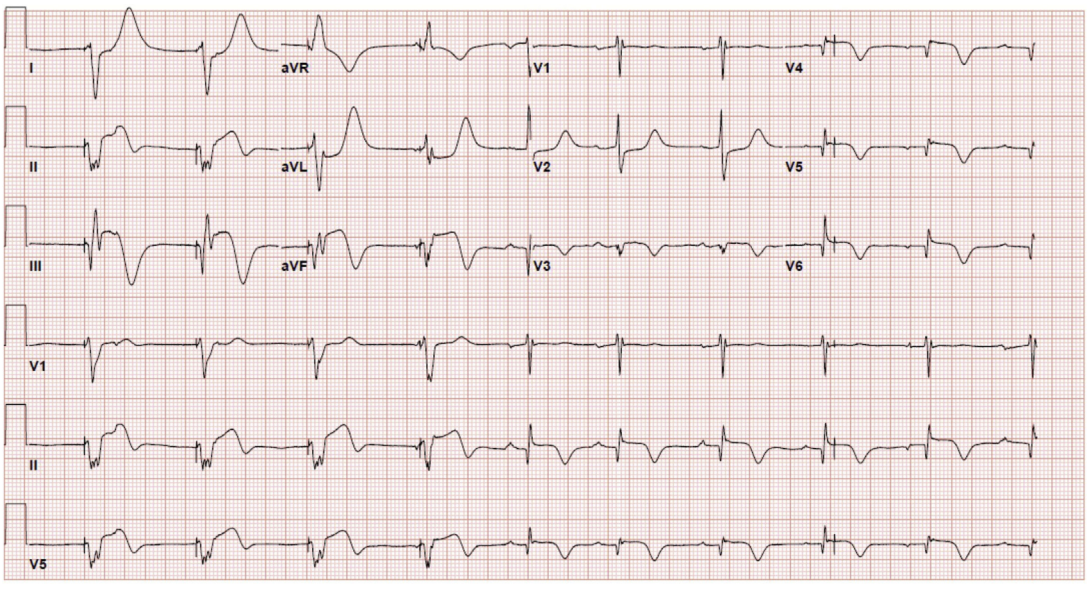
PCI = percutaneous coronary intervention

RCA = right coronary artery

RHF = right heart failure

RV = right ventricular

FIGURE 1 Electrocardiogram Under Transvenous Pacemaker Stimulation



Although difficult to interpret ischemic changes in paced beats, ST-segment elevations in an inferolateral distribution are also present among unpaced beats, suggesting right coronary artery myocardial infarction.

TABLE 1 Hemodynamics Before and After Treatment With a Percutaneous Intraluminal Microaxial RV-Assist Device and High-Risk PCI

	RAP (mm Hg)	PA (mm Hg)	PCWP (mm Hg)	PAPi*	Cardiac Index (L/min/m^2)	CPI† (W/m^2)	Lactate (mg/dL)
Before	20	30/23	20	0.3	1.8	0.24	5.8
After	12	30/20	20	0.8	2.2	0.45	0.6

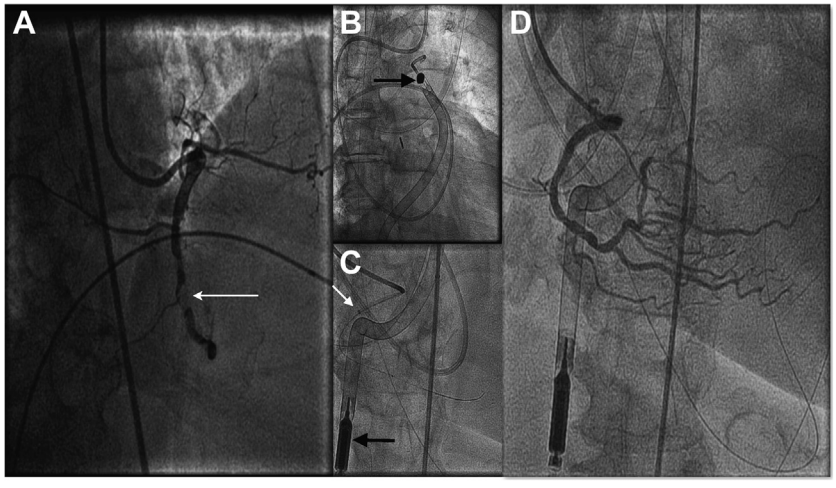
*PAPi = (PA systolic pressure – PA diastolic pressure)/RAP. Normal PAPi is >1.0. †CPI = (cardiac index × mean arterial pressure)/451. Normal CPI ranges from 0.5 to 0.7 W/m^2.
CPI = cardiac power index; PA = pulmonary artery; PAPi = pulmonary artery pulsatility index; PCI = percutaneous coronary intervention; PCWP = pulmonary capillary wedge pressure; RAP = right atrial pressure; RV = right ventricular.

habitus, the patient was not a favorable candidate for venous-arterial extracorporeal membrane oxygenation, nor was surgical revascularization selected given her decompensated clinical state and lack of multivessel disease. A decision was therefore made to pursue high risk-percutaneous coronary intervention (HR-PCI) with right-sided mechanical circulatory support (MCS) (**Figure 2**). A percutaneous microaxial RV assist device (Impella-RP, Abiomed) was inserted via the right common femoral vein, and the IABP remained in place for sequential left ventricular unloading (Video 2). The high anterior take-off of the RCA ostium was engaged non-coaxially with an Amplatz-AL1 guide catheter (Boston Scientific) positioned in the tip of the ostium of the artery without engaging the dissection flap. A hydrophilic guidewire (Whisper ED, Abbott Vascular) was used to successfully navigate the sharp angle and proximal tortuosity and cross the RCA dissection flap. Re-entry of the true lumen was confirmed by visualization of the wire in 2 distal side branches. A 2.5/20 mm balloon was then advanced over the wire, which allowed a guide-extension catheter (Guidezilla, Boston Scientific) to enter the angulated proximal RCA over the balloon shaft. PCI was then performed with placement of 2 drug-eluting stents in the proximal and mid-RCA (4.0 × 12.0 mm and 3.5 × 28.0 mm, respectively) with successful TIMI flow grade 3 after high-pressure balloon post-dilation (Video 3).

DISCUSSION

Management of isolated RHF is a challenging clinical scenario (**Figure 3**). With the goal of correcting the underlying process, immediate options include optimizing RV preload with diuretic agents or volume expansion, minimizing RV afterload with pulmonary vasodilators, and enhancing RV contractility with

FIGURE 2 High-Risk Percutaneous Coronary Intervention of the Right Coronary Artery Dissection



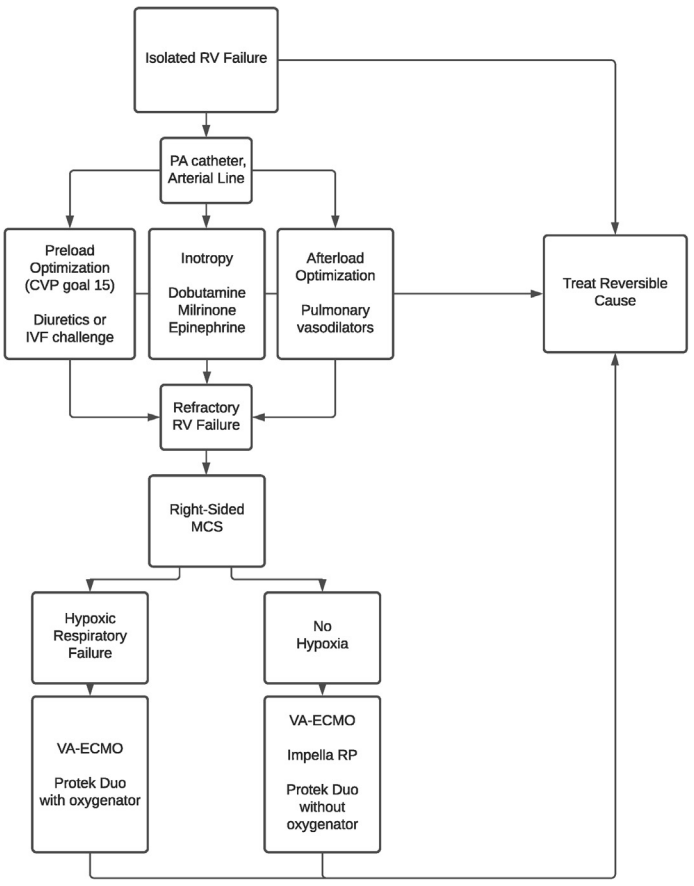
(A) Right coronary artery dissection visible **(white arrow)**. **(B)** Percutaneous intraluminal microaxial RV-assist device outflow in the pulmonary artery **(black arrow)**. **(C)** Non-coaxial guide engagement enhanced by guide-extension catheter **(white arrow)** used for stent delivery after crossing the dissection with a hydrophilic wire and inflow catheter of the percutaneous intraluminal microaxial RV-assist device visible in the inferior vena cava **(black arrow)**. **(D)** Angiography after successful percutaneous coronary intervention.

inotropes (1). Refractory RHF, however, may warrant RV-directed MCS. Options available provide direct RV bypass (ie, percutaneous RV assist devices) or indirect RV bypass (ie, venous-arterial extracorporeal membrane oxygenation). Choice depends on operator comfort level, institutional availability, and whether hypoxia is present. Concomitant left-sided MCS may enhance coronary perfusion pressure, reduce RV afterload, and assist with increased preload from right-sided MCS. In this case, there was no hypoxia or significant left ventricular systolic dysfunction from the acute inferior MI. A percutaneous micro-axial RV assist device with the previously placed IABP device were therefore opted for during HR-PCI, with salvage cardiac surgery planned in case dissection intervention would fail.

Addressing an acute RCA infarction with an iatrogenic, propagating, proximal RCA dissection is a complex intervention requiring longer time and specialized technique. Access to the true lumen must be confirmed, as stent deployment in the false lumen will impede further revascularization attempts. Non-hydrophilic guidewires are generally preferred due to their high tactile feedback, and intravascular ultrasound can be helpful to confirm placement of the guidewire through the true lumen (2). However, this case was particularly challenging given the unusual RCA take-off with proximal tortuosity. We therefore opted for non-coaxial engagement with a suitable angled AL1 guiding catheter and a hydrophilic wire that could safely navigate the challenging anatomy without dislodging our guide. After crossing the lesion and confirming re-entry by visualization of the wire in distal side branches, a guide-extension catheter finally enabled safe stent delivery across the RCA dissected lesion.

The percutaneous intraluminal microaxial RV-assist device used in this case has received approval from the U.S. Food and Drug Administration to treat RHF in the setting of MI, heart transplant, left ventricular assist device implantation, or open-heart surgery given encouraging results from the RECOVER RIGHT (Use of Impella RP Support System in Patients With Right Heart Failure) trial (3). This initial trial had a rather small sample size, and a follow-up U.S. Food and Drug Administration post-approval study cautioned a lower survival rate (4). Further analysis showed that patients meeting original enrollment criteria from the pre-market studies had a more favorable survival compared with those who did not, and extensive contraindications to placement were thereafter established, including unsuccessful revascularization of the RCA. A recent case series in which unsuccessful RCA PCI led to refractory RHF, however, suggested that timely percutaneous intraluminal microaxial RV-assist device insertion led to improvement in hemodynamics and survival at 30 days (5). Patient selection remains important; further randomized clinical trials investigating RV assist devices for HR-PCI in patients with RHF are warranted.

FIGURE 3 Isolated Right Heart Failure Management Diagram



ProtekDuo is a product of TandemLife. CVP = central venous pressure; IVF = intravenous fluid; MCS = mechanical circulatory support; PA = pulmonary artery; RV = right ventricular; VA-ECMO = venous-arterial extracorporeal membrane oxygenation.

FOLLOW-UP

After intervention, the patient's hemodynamics improved (**Table 1**), and she was weaned off vasopressors, inotropics, and MCS over a period of 10 days. Her hospital stay was complicated by renal failure and bacteremia, although she eventually experienced full recovery. She was transitioned to dual antiplatelet therapy and was discharged on hospital day 24. Her survival now extends past 6 months.

CONCLUSIONS

Sequential use of an intravenous $P2Y_{12}$ inhibitor, percutaneous RV hemodynamic support, and HR-PCI are shown in this case. An RV assist device can rapidly offload a failing right ventricle and facilitate complex HR-PCI if implemented correctly in a timely fashion.

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ADDRESS FOR CORRESPONDENCE: Dr George Dangas, Mount Sinai Hospital, One Gustave L. Levy Place, Box 1030, New York, New York 10029, USA. E-mail: george.dangas@mountsinai.org.

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KEY WORDS acute coronary syndrome, acute heart failure, cardiac assist devices, myocardial revascularization, percutaneous coronary intervention, right-sided catheterization, right ventricle

APPENDIX For supplemental videos, please see the online version of this article.