Is right ventricular free wall revascularization underrated? Sequential bypass of mid-right coronary artery to resolve acute right ventricular dysfunction

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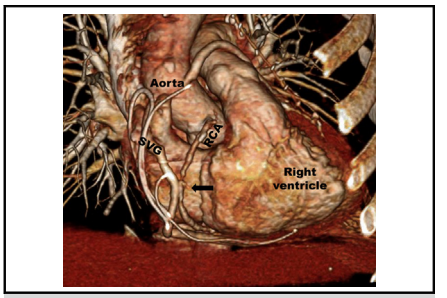


Bypass (*arrow*) of the mid-right coronary artery (RCA) using a saphenous vein graft (SVG).

CENTRAL MESSAGE

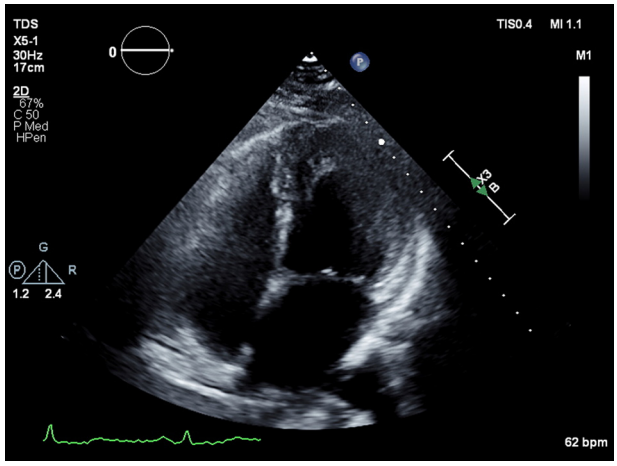
Addressing right ventricle free wall ischemia during coronary bypass surgery can be important in patients with extensive right coronary artery disease to prevent right ventricular dysfunction.

Video clip is available online.

The common practice for coronary artery bypass grafting (CABG) has been to address ischemia of the left ventricular territories (anterior, lateral, and inferior walls) while less commonly addressing right ventricle (RV) ischemia. A number of patients present with extensive right coronary artery (RCA) disease, for which bypassing distal branches alone does not address RV free wall ischemia. Without adequate collateralization between the right and left coronary systems, ignoring RV free wall ischemia can be a cause of early RV dysfunction, as in the case presented here. The patient provided consent for publication of the case data, and Institutional Review Board approval was not required.

CASE PRESENTATION

An 82-year-old woman presented with exertional angina and coronary artery disease and was referred to our institution for CABG evaluation. Her preoperative coronary angiogram demonstrated a mid-RCA lesion (80% stenosis) and a long lesion (75% stenosis) in the proximal part of the posterior descending artery (PDA) (Figure 1). There were no robust collaterals between the left and right coronary systems (Figure E1). Echocardiography showed normal



VIDEO 1. Preoperative transthoracic echocardiographic clip demonstrating normal right ventricular function. Video available at: https://www.jtcvs.org/article/S2666-2507(23)00230-4/fulltext.

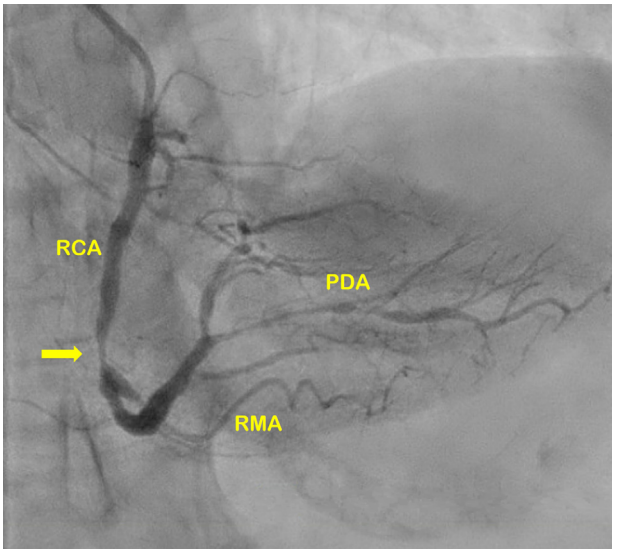


FIGURE 1. Preoperative coronary angiogram showing significant stenosis (*arrow*) of the mid-right coronary artery (*RCA*), a long lesion of the posterior descending artery (*PDA*), and a medium-sized right marginal artery (*RMA*) originating between the 2 lesions.

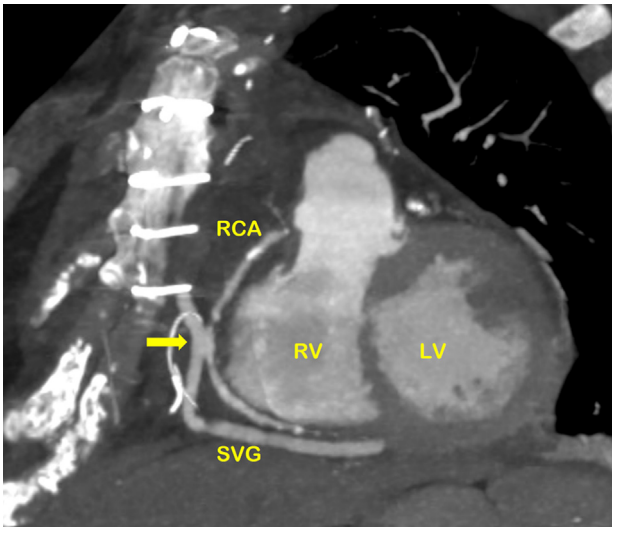
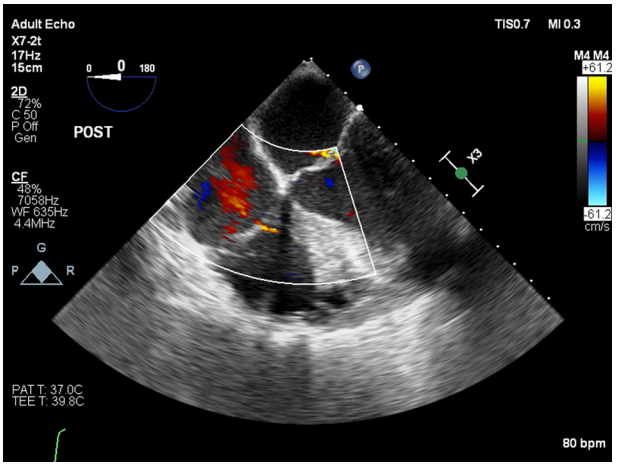


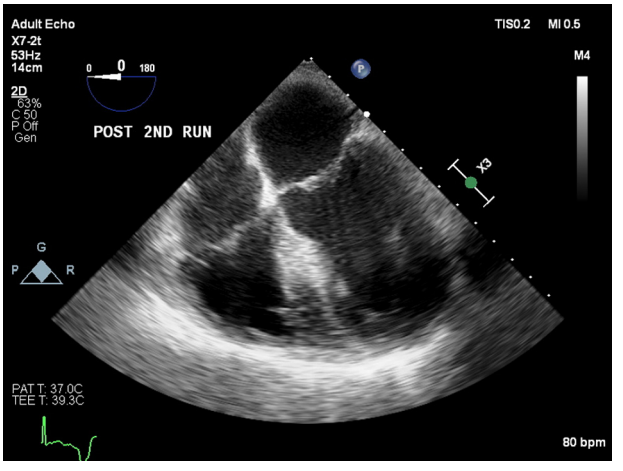
FIGURE 2. Postoperative computed tomography scan showing a patent saphenous vein graft (*SVG*) to the posterior descending artery (*PDA*) with sequential anastomosis (*arrow*) to the mid-right coronary artery (*RCA*). *RV*, Right ventricle; *LV*, left ventricle.

biventricular function (Video 1). She underwent CABG with 4 grafts: left internal thoracic artery to left anterior descending artery, saphenous vein graft (SVG) to the first and second obtuse marginal arteries, and SVG to PDA. The procedure was performed on-pump using antegrade and retrograde blood-based cardioplegia. The proximal SVG anastomoses were performed with aortic cross-clamping and an arrested heart. Adequate deairing was ensured before tying the last proximal anastomosis and then through the aortic root vent.

On separation from the cardiopulmonary pump, we observed new dynamic RV free wall dysfunction, which transiently improved when the systemic blood pressure was increased pharmacologically (Video 2). Transesophageal echocardiography did not show intracardiac air, which could have suggested an air embolism to the RCA. Reperfusion back on-pump for an additional 15 minutes did not resolve the RV dysfunction, and modest doses of inotropes and vasopressors were still required to maintain adequate hemodynamics. Transit time flow was assessed in the bypass grafts and deemed satisfactory according to established parameters.[1] There were no electrocardiographic changes suggesting inferior wall ischemia. RV free wall ischemia was suspected owing to impaired blood flow through a medium-sized right acute marginal artery branch arising between the mid and distal RCA lesions (Figure 1).



VIDEO 2. Post-first pump transesophageal echocardiographic clip demonstrating moderate right ventricular dysfunction. Video available at: https://www.jtcvs.org/article/S2666-2507(23)00230-4/fulltext.



VIDEO 3. Post-second pump transesophageal echocardiographic clip demonstrating improved right ventricular function to low normal. Video available at: https://www.jtcvs.org/article/S2666-2507(23)00230-4/fulltext.

Subsequently, the SVG-to-PDA graft was modified and sequentially anastomosed to the mid-RCA in the atrioventricular groove distal to the mid RCA lesion in a side-to-side fashion. This was performed on-pump with beating heart. Silastic loops were used to occlude the RCA, and bulldog clamps were used to occlude the SVG. After completion of the bypass to the mid-RCA, the patient was weaned from the pump with normal RV function and now minimal pharmacologic support (Video 3).

The patient had an uneventful postoperative course and was discharged home on postoperative day 7. Postoperative echocardiography demonstrated normal RV function, and computed tomography angiography showed patent bypass grafts, including the sequential graft to the RCA and PDA (Figure 2). At a 3-month follow-up, the patient had recovered well, and repeat echocardiogram showed normal RV function.

DISCUSSION

The RV free wall receives blood supply predominantly from the RCA branches. Complete revascularization of extensive RCA disease by bypassing marginal branches, with sequential or separate grafts, has been studied by Turkish groups.[2-4] In these studies, addressing RV free wall ischemia was shown to prevent RV dysfunction and perioperative ischemic events after CABG, especially in patients with left ventricular dysfunction. In the early postoperative period, myocardial protection is commonly blamed for RV dysfunction. We used blood-based cardioplegia both antegrade via the aortic root and retrograde through direct cannulation of the coronary sinus ostium, which is expected to provide adequate protection to the RV through the coronary venous system. Additionally, in our practice, we administer antegrade cardioplegia through the new SVG graft after completing the distal anastomosis. The flow in the PDA graft was checked intraoperatively and was also seen to be patent on postoperative computed tomography angiography. Dramatic improvement in RV function was observed after bypassing the mid-RCA lesion, suggesting RV free wall ischemia as the cause of the acute RV dysfunction.

Acute marginal branches can be relatively small or diffusely diseased in cases of extensive RCA disease. We exposed the mid-RCA in the atrioventricular groove, which can be an ideal target for revascularization of the RV free wall when not densely calcified, supplying multiple RCA marginal branches. To the best of our knowledge, this is the first report of sequential bypass of mid-RCA in the atrioventricular groove to address RV free wall ischemia causing acute RV dysfunction after CABG.

CONCLUSIONS

Addressing RV free wall ischemia is feasible through bypassing the mid-RCA or marginal branches and should be considered in the setting of inadequate collateralization to the RCA system to prevent early RV dysfunction.

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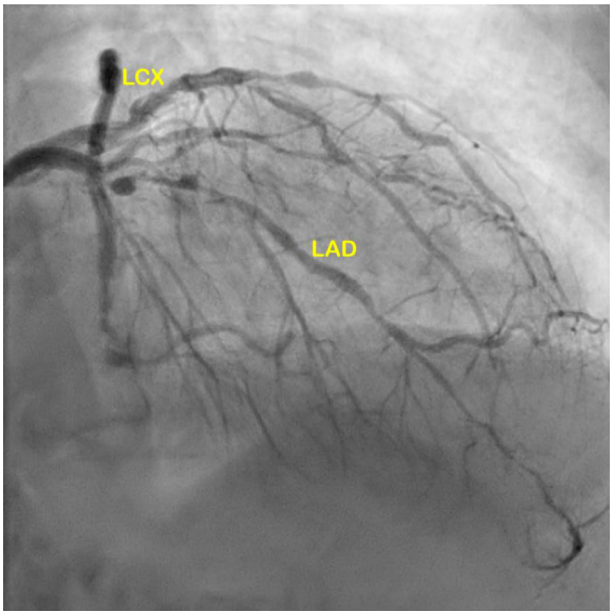

FIGURE E1. Preoperative coronary angiogram showing no significant collateral network between the left coronary artery system—left anterior descending artery (*LAD*) and left circumflex artery (*LCX*)—and the right coronary artery.