Left Main Coronary Artery Occlusion and the Collateral-Dependent Heart

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THE PRESENCE of collateral circulation in areas of myocardium with insufficient perfusion was noted as early as 1969 when Richard Lower described anastomoses between coronary arteries.[1] Understanding the nature of collateral vessels and being aware of their specific pharmacologic responses are essential to protecting the myocardium supplied by these vessels. The authors present a case of chronic complete left main coronary artery occlusion in which the entire left circulation of the heart was supplied by collateral vessels from the right coronary circulation and from noncoronary collateral circulation. This case documents a rare finding and provides for discussion of important considerations regarding anesthetic management of patients with critical coronary disease and coronary collateral vessels.

CASE DESCRIPTION

A 64-year-old man was referred to the authors' hospital with new-onset symptoms of dyspnea and orthopnea, with a history of diabetes, hypertension, and peripheral vascular disease. Physical examination was remarkable for a II/VI systolic murmur heard best over the left lower sternal border and apex, basilar rales, and absence of lower extremity edema. A chest radiograph showed some mild interstitial fluid and borderline cardiomegaly. An electrocardiogram revealed a left bundle-branch block with T-wave inversion across the lateral leads but no Q waves. Transthoracic echocardiogram showed global left ventricular hypokinesis with an ejection fraction (EF) of 20%, moderate-to-severe mitral regurgitation, and mild-to-moderate tricuspid regurgitation. The right ventricle appeared normal and there was mild pulmonary hypertension estimated by tricuspid flow velocities. Dobutamine stress magnetic resonance imaging demonstrated functional and metabolic responses indicating hibernating, viable myocardium without evidence of significant scarring. Coronary angiography prior to surgery revealed complete occlusion of the distal left main coronary artery (Fig 1), which appeared chronic in nature due to the well-developed collateral circulation. The left coronary circulation was visible primarily due to intercoronary collateral filling from the right coronary circulation (Figs 2–4). All major vessels of the left coronary circulation appeared suitable for coronary artery bypass grafting. The patient was placed on a heparin infusion and the cardiac surgery team was consulted, with coronary artery surgery and mitral valve repair/replacement scheduled for the following day.

The chief senior cardiothoracic surgeon contacted the cardiac anesthesia team, voicing his concern about the case. A preoperative intraaortic balloon pump was discussed, but was not inserted due to the patient's significant bilateral iliac vaso-occlusive disease extending into the distal abdominal aorta. The importance of maintaining coronary collateral flow was discussed. The anesthesia plan was to maintain both systolic and diastolic pressure at or above baseline with phenylephrine prior to, during, and after anesthetic induction. A nitroglycerin (NTG) infusion would be added to maintain collateral flow following anesthetic induction and central venous catheter insertion and to potentially reduce the amount of mitral regurgitation as guided by transesophageal echocardiography (TEE). The heparin infusion would be continued until bolus heparin was administered for full anticoagulation prior to cardiopulmonary bypass (CPB). Vasopressin was to be contraindicated prior to coronary revascularization. Since noncoronary collateral flow was likely, mean pressure on CPB was planned to be 50 mmHg to 60 mmHg to reduce washout of cardioplegia.

On the morning of surgery, a left radial arterial catheter was placed prior to the induction of anesthesia during mild sedation with intravenous midazolam, 2 mg, while vital signs were monitored. There were no concerns about the patient's airway. An intravenous induction was accomplished with fentanyl, 10 μ/kg, followed immediately with pancuronium, 0.1 mg/kg, and etomidate, 0.1 mg/kg. Intermittent boluses of phenylephrine were administered to maintain systemic resistance and coronary perfusion pressure (CPP) at baseline. Maintenance anesthesia consisted of isoflurane, 0.2% to 0.8%, and a fentanyl infusion at 100 μ/h to 150 μ/h. After induction, a TEE probe and a pulmonary artery catheter were placed for monitoring. Cardiac index was initially 1.8 L/min/m^2, SvO_2 was 83%, and pulmonary artery pressures were 40/22 mmHg, while blood pressure was 110/80 mmHg. Nitroglycerin was started at 20 μ/min with phenylephrine infusion to maintain CPP. Cardiac index increased to 2.1 to 2.2 L/min/m^2, while pulmonary diastolic pressure decreased to 16 mmHg to 18 mmHg and SvO_2 increased to 87%. The TEE revealed markedly reduced left ventricular function, with an EF of 20% and moderate-to-severe mitral regurgitation with restrictive-appearing leaflets. A large left-to-right intra-atrial septal defect was discovered. Diastolic blood pressure was maintained at 80 mmHg until time to prepare for aortic cannulation. The heparin infusion was discontinued after 300 units/kg of heparin were administered.

Intraoperatively, the mitral valve was exposed via a superior septal incision, and a large atrial septal defect was observed. There was no calcification of the mitral leaflets or of the annulus, but the leaflets and subvalvular apparatus were scarred and tethered. The valve was not amenable to repair. The annulus sized to a 31-mm St. Jude Medical Epic Supra Stented Porcine Bioprosthesis (St. Jude Medical, Inc., St. Paul, MN). Four-vessel coronary artery bypass grafting was performed with vein grafts to the posterior descending, first obtuse marginal, and first diagonal arteries with an internal mammary artery graft to the left anterior descending. It was noted during distal anastomoses that continuous suction was required to

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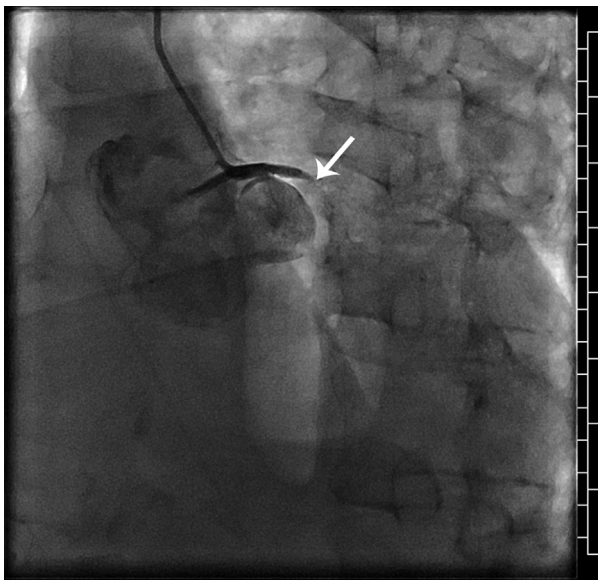

Fig 1. Left anterior oblique cranial image from coronary angiograms revealing complete occlusion of the distal left main coronary artery.

visualize the anastomotic site despite intermittent retrograde cardioplegia that was indicative of significant noncoronary collateral flow. The proximal anastomoses were performed with a single cross-clamp technique. The patient separated uneventfully from CPB on inotropic support (milrinone and epinephrine) and was transported to the intensive care unit in stable condition.

The patient had a stormy postoperative course that included respiratory failure and tracheostomy. Postoperative transthoracic echocardiography revealed the EF had improved to 30% to 35%, with prosthetic valve function normal. The patient eventually was discharged from the hospital with improvement in heart failure symptoms and no anginal symptoms.

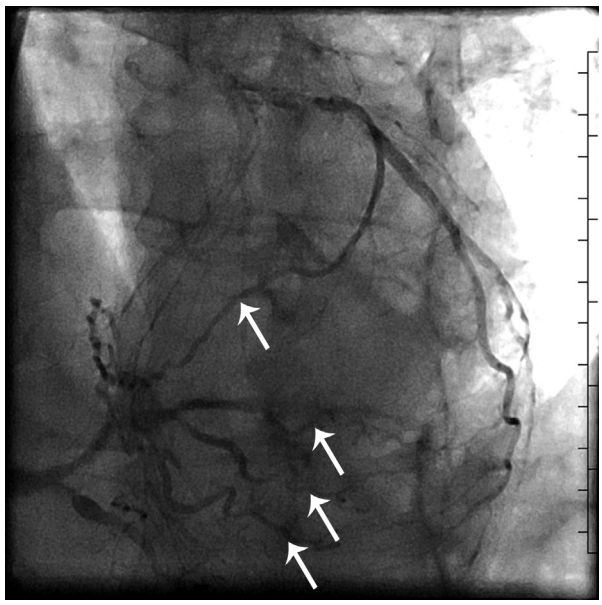

Fig 3. Left anterior oblique image showing collateral flow predominantly from the posterior lateral branch filling retrograde into the left coronary circulation. Arrows illustrate large grade 3-collaterals.

DISCUSSION

A patient surviving a total left main coronary artery occlusion is extremely rare. This case was the first total left

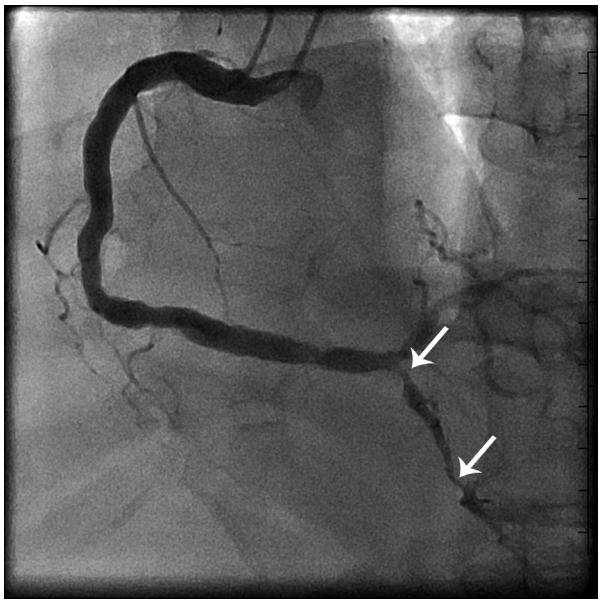

Fig 2. Left anterior oblique cranial image of enlarged right coronary artery with irregularities and the posterior lateral and posterior descending arteries. Arrows denote the critical lesions of the posterior descending artery.

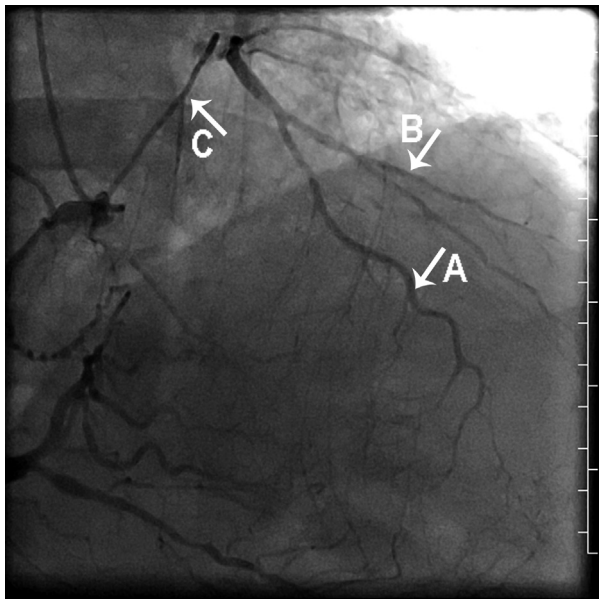

Fig 4. Right anterior oblique cranial image showing collateral filling through the septal perforators to the left anterior descending (Arrow A) and a large diagonal branch (Arrow B) and the circumflex artery (Arrow C).