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Coronary to Pulmonary artery fistula: Surgical management using a pump assisted beating-heart technique

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Abstract

Background: Coronary arteriovenous fistulae (CAVF) are rare anomalies with an incidence of 0.002% in the general population. The majority of CAVF drain into adjacent structures such as the pulmonary artery, coronary sinus, or the superior vena cava (SVC). Patients can remain asymptomatic or can present with dyspnea, fatigue, and angina. Serious complications include pulmonary hypertension, congestive heart failure, coronary steal, endocarditis, myocardial ischemia, thrombosis, or rupture of the fistula.

Case presentation: A 59-year-old male presented to the emergency room with chest pain. He was diagnosed with a NSTEMI and underwent cardiac catheterization that demonstrated severe coronary artery disease (CAD) and a left coronary artery to pulmonary artery fistula. CT angiography (CTA) revealed a large cluster of small vessels abutting the anterior wall of the right ventricular outflow tract (RVOT) with communication and connection of the artery and its cluster to the proximal left anterior descending (LAD) artery. The patient developed further chest pain with EKG changes concerning for a STEMI. The decision was made to proceed with urgent coronary artery bypass grafting (CABG) and fistula ligation using a pump-assisted beating-heart technique. CABG was performed to the LAD, OM1 and posterolateral branch of RCA. Ligation of the fistula was achieved with a Teflon felt mattress pledgetted 3-0 prolene suture. The pump assist technique allowed optimal visualization and elimination of the fistulous communication after ligation with real-time assessment of the ST-segments. The hospital course was uneventful with normalization of the electrocardiogram postoperatively.

Conclusion: CAVF continues to be a rare but serious anomaly requiring surgical intervention to relieve symptoms. We believe that our pump assisted beating heart technique optimizes visualization during surgery and helps in ensuring complete elimination after ligation of the fistula with real-time assessment of hemodynamics and ST-segments during the procedure.

Introduction

Coronary arteriovenous fistulae (CAVF) are rare anomalies with an incidence rate of 0.002% in the general population. (1) Any or all three coronary arteries can be involved with the majority of CAVFs draining into adjacent structures such as the pulmonary artery, coronary sinus, or the superior vena cava (SVC). Patients can remain asymptomatic or can present with dyspnea, fatigue, and angina. Serious complications include pulmonary hypertension, congestive heart failure, coronary steal, endocarditis, myocardial ischemia, thrombosis, or rupture of the fistula. The traditional

approach to CAVF repair involves cardiopulmonary bypass (CPB) with cardioplegic arrest and epicardial ligation of the fistula. The traditional technique, however, does not permit real-time hemodynamic or ST-segment assessment until the aortic cross-clamp is removed and CPB is weaned. Depending upon the influence of nature and magnitude of the fistula, significant alterations in hemodynamics and coronary circulation may occur with the need for revisions or modifications thereafter. Utilizing a beating-heart technique allows for real-time assessment of the hemodynamics and coronary blood flow during the repair.

Case Presentation

A 59-year-old Vietnamese speaking male presented to the emergency room (ER) with chief complain of chest pain. He described the chest pain as exertional, mid-sternal in location radiating to the left shoulder, along with shortness of breath. This condition had been present for several years. He also reported having had a stroke in the past (with no residual deficits) but did not seek medical attention. In the ER, he was found to be afebrile and hemodynamically stable. However, he had significantly elevated high-sensitivity troponin (271 ng/L, normal < 34 ng/L) and an EKG showing T-wave inversions in the inferior leads. He was given aspirin (325 mg) and started on a heparin drip in accordance with the guidelines for a non-ST-segment elevation myocardial infarction (NSTEMI).

He underwent Transthoracic echocardiography (TTE) which showed no chamber enlargement, normal contractility of both ventricles with no definite wall motion abnormalities, and no significant valvular disease.

He underwent Cardiac Catheterization that showed the following: Severe heavily calcific RCA disease. Moderate to severe diffuse heavily calcific LAD disease. Left coronary artery to pulmonary artery fistula with normal filling pressures and a cardiac index of 3.9 L/min/m².

On Day 4 of hospitalization, he re-developed chest pain with mild ST segment elevation on the EKG inferiorly. The patient was given nitroglycerine and re-started on a heparin drip with symptomatic and electrocardiographic relief. A CT Angiogram (CTA) of the Chest was performed that demonstrated a large cluster of small vessels abutting the anterior wall of the Right ventricular outflow tract (RVOT) and the main pulmonary artery on the left with communication of the lumen of the artery slightly distal to the pulmonic valve. This fistulous communication connected to the proximal LAD (Figure 2). In view of these findings, the patient was advised to undergo CABG and Coronary-to-Pulmonary Artery fistula ligation.

In the operating room, the transesophageal echocardiography (TEE) demonstrated flow in the fistula from the LCA to the main pulmonary artery (Figure 3). Additional findings included heavily calcified coronary arteries, anthracotic lungs, and the fistulous vessels originating from the proximal LAD coursing overtop the main pulmonary artery (Figure 4). Utilizing a pump-assisted beating-heart technique, bypass grafts were performed to the LAD, LCX-OM branch, and the PLB branch of the RCA. The fistula ligation was performed with deeply placed 4-0 Prolene mattress Teflon pledgetted sutures overtop the proximal portion of the visible fistulous vessels on the anterior aspect of the pulmonary artery (Figure 5). Following placement of the sutures, flow through the vessels distal to the ligation was no longer seen. The EKG and hemodynamics during the case and following separation from CPB were observed in real-time and no abnormalities in either were observed. The postoperative course was

uneventful with complete resolution of the abnormal ST-segments observed on the EKG preoperatively (Figure 6).

Discussion and Conclusions

Coronary artery fistulas (CAF) are rare anomalies that result when a coronary artery has an anomalous connection either to the great vessels or a cardiac chamber. The incidence is 0.1% to 0.2% in adults. Coronary artery to pulmonary artery fistula (CPAF) is a rarer type accounting for 15-30% of CAFs (1). A review of congenital CAFs in adults over a 10-year period was described by Said in which 304 patients were described (2). The authors describe a variety of presentations, diagnostic modalities, and treatment options. The review does not, however, specifically identify a beating-heart technique for fistula ligation. In a separate manuscript, Albeyoglu and colleagues described their surgical experience with twenty-one patients with CAFs (3). In this report, some patients underwent CAF ligation with a beating-heart technique only when the pathology was associated with “coexisting ASD, valve or coronary occlusive disease and unfavorable anatomy of fistulas”. Cardiopulmonary bypass with aortic cross-clamping and cardioplegic arrest, for example, was used in patients when CAF ligation combined with CABG.

In general, CAFs can remain asymptomatic, or patients can present symptoms of shortness of breath or volume overload depending upon the location and magnitude of the shunt through the fistula. In rare cases, coronary to pulmonary artery fistulas can also present with spontaneous rupture causing cardiac tamponade and/or sudden cardiac death (4,5). In our case, the patient exhibited chronic shortness of breath and acute chest pain. Likely, the dyspnea may have been from the fistula separate from or in combination with his smoker's lungs. The chest pain was from the CAD and its accompanying MI.

The modalities used for diagnosing CPAF include Transthoracic echocardiography (TTE), coronary angiography (CAG), and CT angiogram of the chest with 3D reconstruction (6). The TTE is non-invasive but is limited in rendering information about coronary anatomy and its relationship to adjacent structures. CAG remains the gold standard to diagnose CPAF but is an invasive procedure and is also limited by 2-dimensional imaging making it difficult to visualize complex anatomical details. In this case, we also used CT chest angiography with 3D reconstruction to obtain a complete picture of this complex problem, and it significantly helped with pre-operative planning.

The recommendation to intervene and close CAFs are for patients in which the fistula demonstrates a significant shunt or causes symptoms such as pulmonary hypertension (7), myocardial ischemia due to steal syndrome (8), ventricular dysfunction or cardiac arrhythmias (9). The various methods to close CAFs include percutaneous closure using devices such as coils, plugs, duct occluders and stents (10). The majority, however, are closed surgically. In our case, the

patient had multivessel coronary artery disease with EKG changes and therefore a decision was made to address these problems utilizing a surgical approach.

In the traditional approach, CABG surgery is conducted through a median sternotomy followed by initiation of cardiopulmonary bypass (CPB) with aortic cross-clamping and cardioplegic cardiac arrest. While this technique affords a motionless field to work in, there are several disadvantages. First, blood flow through the fistula is absent making visualization more difficult and complete eradication somewhat more imprecise. In addition, the EKG during induced cardiac arrest is flatline such that the effects of ligating the fistula may not be apparent—from a coronary ischemia standpoint—until after the cross clamp is removed and electrical activity is restored. Theoretically, ligation of the fistula may compromise native coronary blood flow which would not be appreciated until after the ligation and restoration of electrical cardiac activity. The

beating-heart technique, however, allows for real-time assessment of the EKG on the monitor with the ability to assess for changes during the ligation and the possibility of modifying the ligation prior to committing to it permanently. Similarly, hemodynamics can also be assessed visually and by intraoperative TEE when the ligation is being performed. In this case, we describe the merits of the beating-heart technique—excellent visualization of the fistula with precise ligation of it and not the coronary artery proper. We were able to determine visually, electrocardiographically, and echocardiographically that the fistula was completely ligation with no injury to the native coronary artery and no hemodynamic or wall motion abnormalities as a result of the ligation.

In conclusion, we advocate the use of a beating-heart technique for the surgical treatment of CAFs and lesions like them to minimize risk and maximize outcomes.

Figure 1: Cardiac catheterization demonstrating LCA to PA fistula

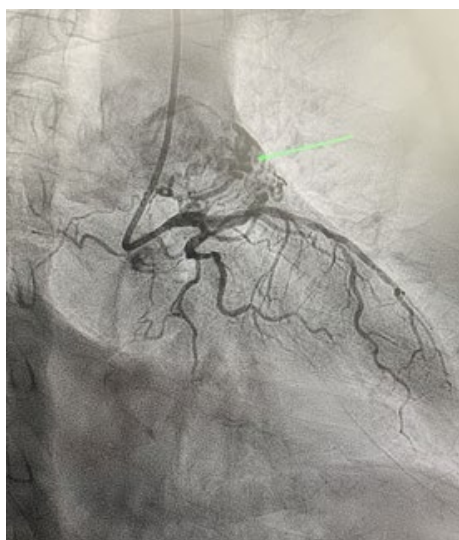


Figure 2: CT chest angiography and 3D reconstruction

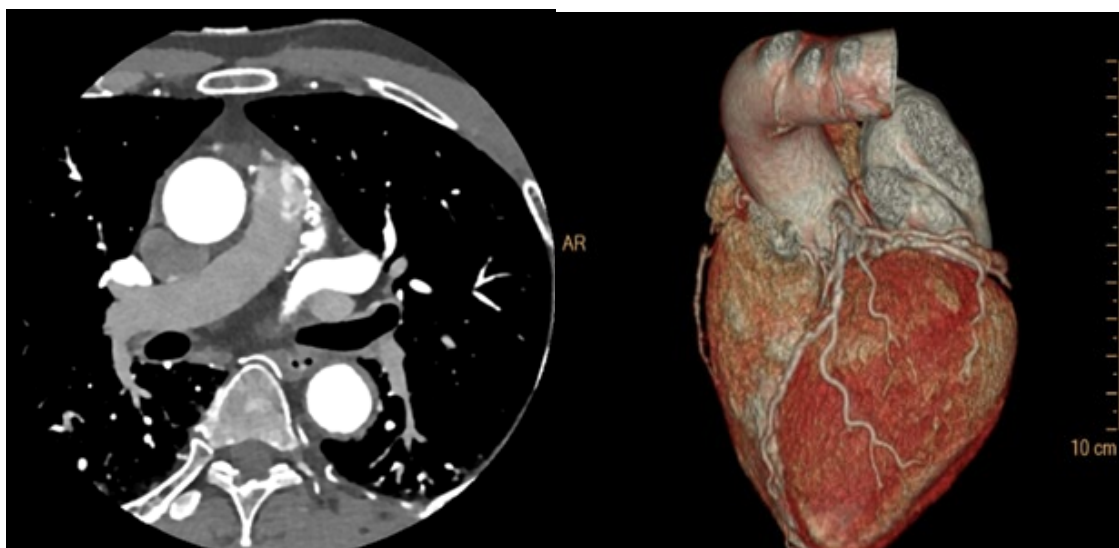


Figure 3: Intraoperative Transesophageal Echocardiography (normal anatomy and fistula)

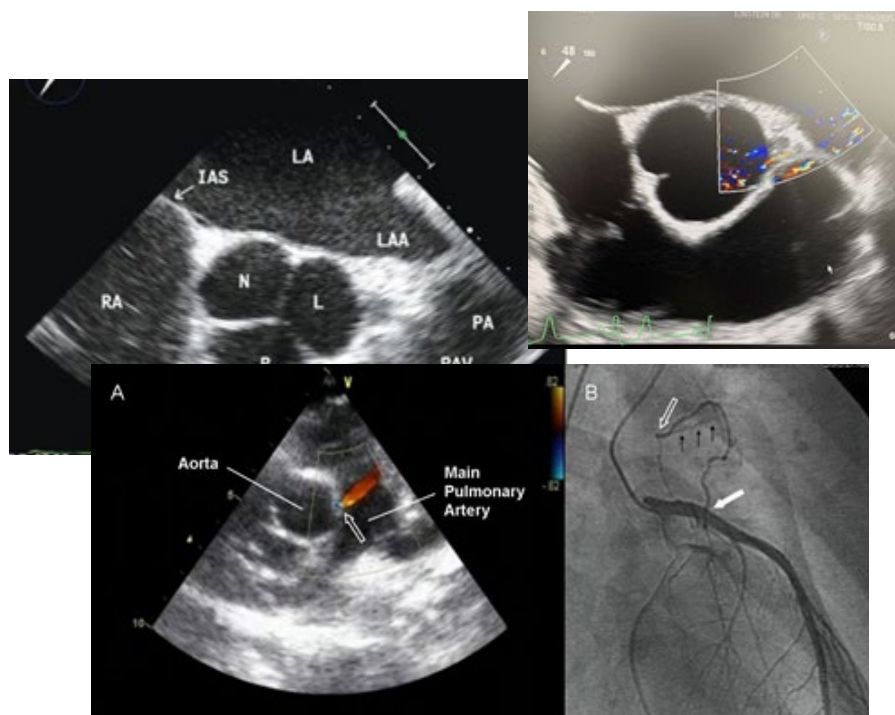


Figure 4: Intraoperative Photo (serpentine vessels adjacent to aorta lying overtop pulmonary artery at tip of forceps)

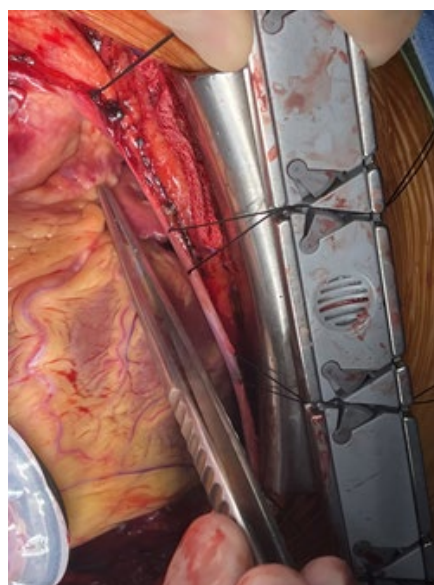


Figure 5: Fistula Ligation Illustration—deep mattress-pledgetted 4-0 Prolene sutures

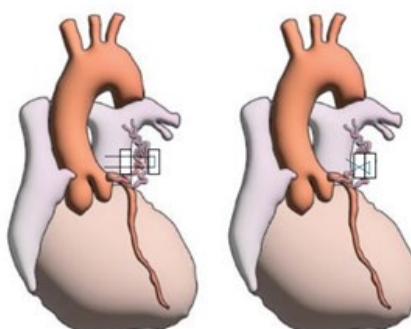
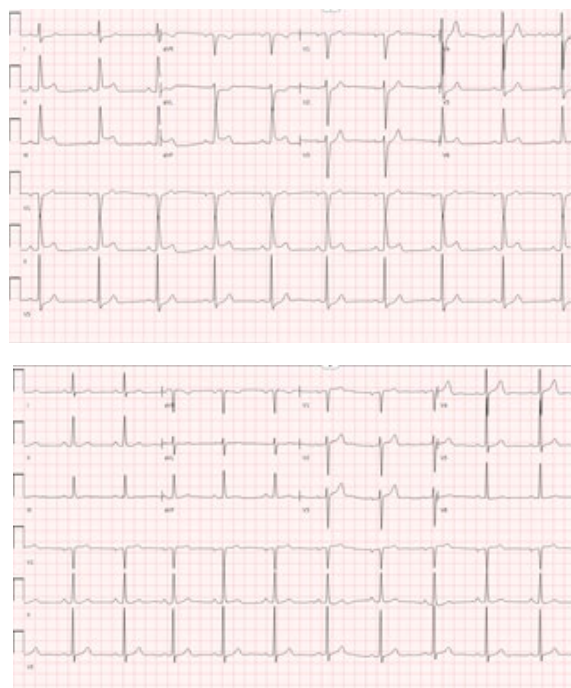


Figure 6: Pre & Postop EKG—note the ST segment elevations on the preop EKG and resolution of them on the postop EKG



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