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CASE REPORT

Left Internal Mammary Artery-pulmonary Artery Fistula after CABG: Successful Closure Using a Modified Balloon Technique

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ABSTRACT

Fistulas between arteries and veins may be either congenital or acquired, and their management typically depends on the presenting symptoms. While initial treatments were surgical, advancements in both technology and clinical expertise have facilitated the adoption of less invasive percutaneous catheter-based approaches. In this report, we detailed a technique we employed to close a fistula that developed between the left internal mammary artery and the pulmonary artery following bypass surgery. The method involved cutting a coronary balloon under sterile conditions, which led to thrombosis as a result of retrograde blood filling.

Keywords: Fistula, coronary artery bypass grafting, pulmonary artery

INTRODUCTION

Fistulas between the internal mammary artery (IMA) and the pulmonary artery (PA) are relatively uncommon.[1] These fistulas may be congenital, acquired, or iatrogenic in origin. Acquired fistulas are generally associated with inflammation, infection, or neoplastic processes, whereas iatrogenic fistulas most often result from surgical trauma. Patients with congenital or acquired fistulas typically present with symptoms such as hemoptysis, dyspnea, chest murmur with trill, and chest pain. In iatrogenic cases, recurring angina due to steal syndrome may be detected incidentally, either with hemoptysis or in the absence of symptoms.[2] In our case, the patient was asymptomatic regarding the fistula and was incidentally diagnosed with an inferior myocardial infarction (MI) related to the right coronary artery (RCA). A fistula between the left IMA (LIMA) and the PA was identified during coronary angiography.

CASE REPORT

A 64-year-old male patient had undergone coronary artery bypass grafting (CABG) surgery 11 years prior. He presented to our clinic with a diagnosis of inferior MI and subsequently underwent emergency percutaneous coronary intervention (PCI) of the RCA. Imaging revealed a 99% occlusion of the left anterior descending artery (LAD), a fistula extending from the proximal segment of the LIMA to the PA, and minimal distal flow (Figure 1).

Transthoracic echocardiography and thoracic computed tomography confirmed the presence of a fistula originating from the LIMA to the PA. Considering the angiographic visibility of the fistula and the risk of reduced myocardial perfusion secondary to the coronary steal phenomenon, closure of the fistula was considered appropriate. In this report, we describe a novel technique for closing a LIMA-to-PA fistula that developed after coronary bypass surgery.

This innovative technique entails cutting a coronary balloon under sterile conditions, resulting in intraluminal thrombosis due to retrograde blood entry against the natural direction of flow. The patient, who was admitted with acute coronary syndrome, was found to have a fistula between the LIMA and the PA during the initial angiographic evaluation. A total occlusion of the RCA was treated with two PCIs, using 3 × 23-mm and 3.5 × 28-mm stents. Postdilation was performed with a 3.5 × 20-mm noncompliant balloon to ensure complete vessel patency. Three days later, predilation of the native LAD was carried out using a 2.5 × 15-mm balloon. A 7-F internal mammary catheter was introduced into the LIMA using a guiding catheter, and a 0.014-inch floppy wire was advanced. A 1.5 × 10-mm balloon was cut and mounted onto the wire, with the cut surface positioned against the direction of flow. After inflation to 4 atm for 30 seconds, the balloon was deflated, and its distal shaft was severed. The balloon was then separated into two parts (the main shaft and distal segment), which were reloaded separately onto the wire in a configuration that created a parachute effect. This assembly was guided to the target site,

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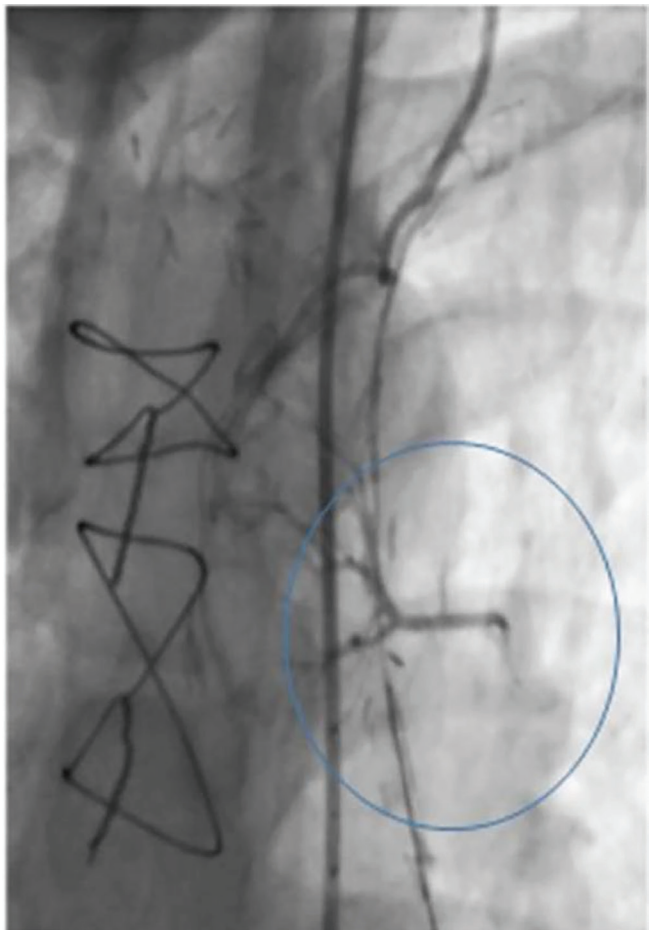

Figure 1. Imaging of the left coronary system and grafts revealed 99% occlusion of the left anterior descending artery. A fistula was also noted originating from the proximal portion of the left internal mammary artery to the pulmonary artery, with minimal distal flow observed

where the cut balloon was partially deployed. The proximal shaft was secured against the bronchial artery to allow controlled release. Owing to the one-way arterial flow, the device expanded slightly and became lodged at the fistula site. The wire was carefully withdrawn, leaving the embolic balloon components in place. Five minutes after deployment, angiography confirmed reduced flow to TIMI grade 1 and decreased fistulization. The procedure concluded without complications (Figures 2-4).

DISCUSSION

Fistulas between the LIMA and the PA are uncommon vascular anomalies. According to a study by Madu et al.[3], the incidence of PA fistulas following CABG procedures involving the LIMA was 0.67% among 595 cases. Similarly, Guler et al.[4] reported a LIMA-PA fistula incidence of 0.93% (5 out of 537 patients) based on follow-up angiography after CABG. They noted that the true prevalence in the general population might be underestimated due to typically asymptomatic nature of these fistulas. Furthermore, such fistulas are generally identified between 2 and 5 years postoperatively.[5]

Figure 2. (A) The balloon was inflated to 4 atm pressure. B) After 30 seconds, the balloon was deflated and detached by cutting from the distal shaft. C) The balloon was then cut in half. D) The main shaft and the distal segment of the balloon were prepared separately and loaded onto the floppy wire with the cut surface facing against the direction of flow (parachute effect)

Figure 3. The main shaft and the cut distal portion of the balloon were mounted on a 0.14-inch wire for navigation to the target artery

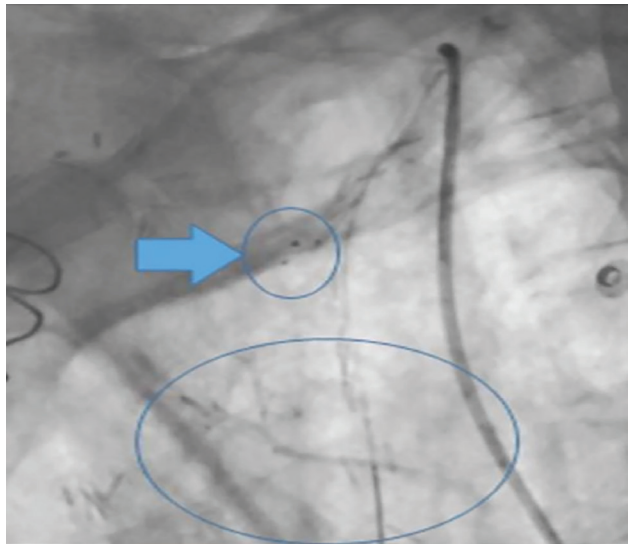

Figure 4. Post deployment imaging showed that blood flow in the fistulized side branch of the left internal mammary artery was reduced by approximately 90%

While most of these fistulas are asymptomatic, symptomatic cases present with angina, dyspnea, hemoptysis, and an intrathoracic murmur.[6,7] Management strategies include medical observation with symptomatic relief, catheter-based interventions, embolization using coils or glue, balloon occlusion, and surgical repair.[8]

Angina is the most frequently reported symptom, primarily due to the steal phenomenon, in which the lower pressure within the PA diverts coronary blood flow, resulting in myocardial ischemia.[9] When determining a treatment approach, clinicians should assess the severity of symptoms. Although there is broad consensus regarding intervention indications, many authors highlight the importance of hemodynamic assessment using various diagnostic tools.

For instance, Reis et al.[10] recommended the use of intravenous Doppler ultrasound and angiography to assess the functional significance of LIMA-LAD fistulas in patients after bypass surgery. Similarly, Nielson and Kang[11] employed myocardial perfusion scintigraphy followed by conventional angiography to identify ischemic regions in symptomatic individuals.

In asymptomatic cases, conventional angiography is generally considered adequate for diagnosis, particularly within the first 2-5 years following CABG. Abbott et al.[12] reported the successful closure of a LIMA-PA fistula using a polytetrafluoroethylene-coated stent. Although the stent remained patent and the fistula was closed after the procedure, the patient subsequently died due to multiple organ failure. With the advent of intravascular adhesive agents, glue embolization of the fistulous tract has become an additional therapeutic option, though it presents a higher risk of unintended embolization.

In a technique similar to ours, Jagadeesan et al.[13] employed a balloon to occlude the fistulous tract, injected adhesive into the distal segment, and kept the balloon inflated until the material solidified, after which the device was withdrawn. Carminati et al.[14] also used a coronary balloon to assess the fistula's morphology and assist in determining the appropriate closure strategy. Furthermore, Pop et al.[15] reported, for the first time, the use of temporary balloon protection of the vein of Labbé during embolization of a dural arteriovenous fistula to preserve cortical venous drainage.

In our clinic, we have applied this method in several patients presenting with massive hemoptysis after high-risk thoracic surgery for lung cancer.[16] At that time, instead of bisecting the balloon, we chose to cut it at the shaft and position the distal portion within the fistulous side branch to induce thrombosis. Due to the emergency nature of the cases and the unavailability of coils or alternative devices, the procedure was successfully carried out using a coronary balloon.

CONCLUSION

After the patients had stabilized, we refined the procedure by cutting the balloon in half and allowing the blood to fill the cut tip in a direction opposite to flow, thereby creating a parachute effect that helped occupy the lumen of the fistulized vessel. Our short-term outcomes were highly successful. We recommend this technique as it can be performed in any angiography laboratory using standard equipment, and it is both cost-effective and simple to execute once the operator is familiar with the method.

Informed Consent: Written informed consent was obtained from the patient for the publication of this case report and any related images.

Presented in: This study was presented as a poster at the 30th National Applied Interventional Cardiology Congress in 2023 and included in the congress proceedings.

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