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Invasive Management of Iatrogenic Left Internal Mammary Artery-Great Cardiac Vein Anastomosis: A Case Report

İyatrojenik Sol İnternal Meme Arteri-Büyük Kardiyak Ven Anastomozunun İnvaziv Yönetimi

ABSTRACT

Coronary artery bypass graft (CABG) surgery is one of the main treatment procedures for revascularization. Diagnosing postoperative complications can be difficult. One rare complication is the iatrogenic connection of the graft to the venous system, causing distal ischemia due to an arteriovenous shunt. This condition may lead to heart failure and fatal arrhythmias. Anti-arrhythmic drug-resistant ventricular arrhythmias, which can occur immediately after coronary artery bypass surgery, are sometimes related to the procedure itself. We describe the invasive management of an iatrogenic anastomosis between the left internal mammary artery (LIMA) and the great cardiac vein (GCV), which led to life-threatening ventricular arrhythmias.

Keywords: Cardiac surgery, complication management, fistula closure, percutaneous intervention, ventricular tachycardia

ÖZET

Koroner arter bypass grefti (KABG) ameliyatı, revaskülarizasyon için ana tedavi prosedürlerinden biridir. KABG sonrası komplikasyon tanısı koymak zor olabilir. Arter greftin venöz sisteme iyatrojenik olarak bağlanması nadir görülen bir komplikasyondur. Arteriyovenöz şant nedeniyle distal iskemiye neden olur. Bu durum kalp yetmezliğine ve ölümcül aritmilere yol açabilir. Koroner arter baypas cerrahisinden hemen sonra ortaya çıkan anti-aritmik ilaca dirençli ventriküler aritmiler bazen işlemle ilişkili olabilir. Bu yazıda, yaşamı tehdit eden ventriküler aritmilere yol açan iyatrojenik sol internal meme arteri (LIMA) ile büyük kardiyak ven (GCV) anastomozu olgusunun invasive yönetimini sunulmuştur.

Anahtar Kelimeler: Kardiyak cerrahi, komplikasyon yönetimi, fistül kapatma, perkütan girişim, ventriküler taşikardi

CASE REPORT
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Coronary artery bypass graft (CABG) surgery is one of the main treatment procedures for revascularization. Diagnosing complications post-CABG can be challenging. The iatrogenic connection of the graft to the venous system is a rare but serious complication, leading to distal ischemia due to an arteriovenous shunt. This can result in heart failure and fatal arrhythmias. Anti-arrhythmic drug-resistant ventricular arrhythmias that occur immediately after coronary artery bypass surgery may be related to the procedure. We report a case where an iatrogenic left internal mammary artery (LIMA) to great cardiac vein (GCV) anastomosis caused life-threatening ventricular arrhythmias.

Case Report

A 65-year-old man was referred to the arrhythmia unit for ventricular tachycardia ablation due to antiarrhythmic drug (AAD) refractory ventricular arrhythmia, which occurred three days post-CABG. The patient experienced both sustained and non-sustained ventricular tachycardia episodes despite receiving antiarrhythmic drugs (intravenous lidocaine and amiodarone) and underwent multiple defibrillations. A ventricular tachycardia storm subsequently led to cardiac arrest. His medical history included diabetes, coronary artery disease, and heart failure with a low ejection fraction (LVEF 30%). Initial electrocardiograms (ECGs) displayed polymorphic ventricular tachycardia and an extended QTc interval (Figure 1). Upon admission, serum potassium and magnesium

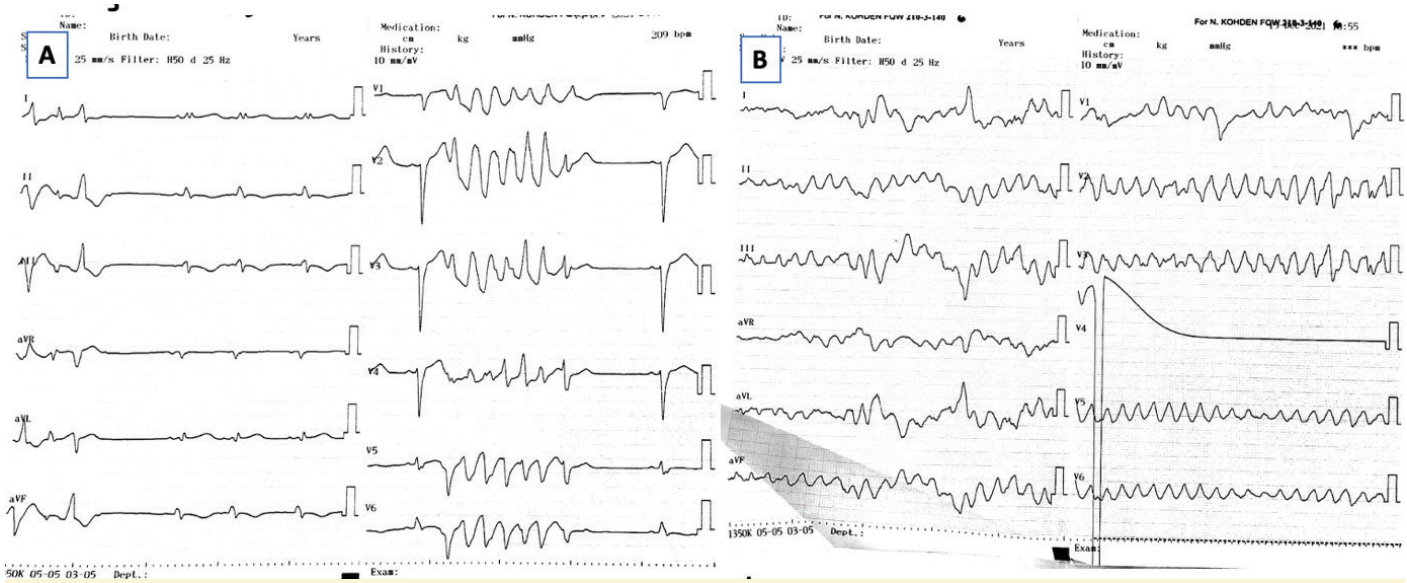

Figure 1. (A) Initial ECG reveals sinus rhythm, polymorphic ventricular premature beat, non-sustained polymorphic ventricular tachycardia and long QTc (QTc 520 ms). (B) Sustained polymorphic ventricular tachycardia.

levels were 3.8 (3.5-5.1) and 0.86 (0.73-1.06) mmol/L, respectively. Thyroid function tests, hemograms, and other biochemical parameters were normal. The patient was initially sedated, and electrolyte replacement therapy was administered. Coronary angiography was conducted to rule out ischemia, revealing an 80% occlusion in the native proximal left anterior descending (LAD) artery, a completely occluded circumflex (Cx) artery, and an 80-90% lesion in the right coronary artery (RCA). All saphenous vein grafts were patent (right coronary artery saphenous vein graft [RCA-SVG], circumflex artery saphenous vein graft [CX-SVG], and first diagonal branch saphenous vein graft [D1-SVG]). An inappropriate anastomosis between the left internal mammary artery and the great cardiac vein was identified (Figure 2 A-B, Videos 1, 2). The Heart Team decided to perform percutaneous revascularization of the native LAD artery and, if necessary, subsequent occlusion of the left internal mammary artery-coronary sinus (LIMA-CS) anastomosis. A 3.0 x 30 mm drug-eluting stent (DES) was placed in the proximal lesion, and a 2.75 x 23 mm DES was used for the distal lesion. Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow was observed in the LAD and diagonal region (Figure 3, Video 2). Due to refractory post-procedural ventricular tachycardia (VT) episodes, occlusion of the LIMA to GCV anastomosis was executed. The day following LAD revascularization, QT prolongation persisted on ECG (Figure 4). Initially, the balloon embolization technique was employed to attempt to occlude the anastomosis; however, the balloon migrated distally and became thrombosed, inadequately reducing flow (Figure 5, Video 4). Coil embolization was subsequently performed using a Concerto 5.0 x 20 mm coil through a Rebar 0.027 micro-catheter (Figure 6, Video 5). After the placement of two coils, flow through the anastomosis was completely obstructed. No angina or arrhythmic episodes were observed. Post-procedure ECG revealed sinus rhythm and QTc 460 ms (Figure 4B). The patient was discharged after one week of follow-up.

ABBREVIATIONS

AAD	Antiarrhythmic drug
ACS	Acute coronary syndrome
CABG	Coronary artery bypass graft surgery
CX	Circumflex artery
DES	Drug-eluting stent
ECG	Electrocardiogram
GCV	Great cardiac vein
LAD	Left anterior descending artery
LIMA	Left internal mammary artery
LVEF	Left ventricular ejection fraction.
QTc	Corrected QT interval
RCA	Right coronary artery
SVG	Saphenous vein graft
TIMI	Thrombolysis in Myocardial Infarction
VF	Ventricular fibrillation
VT	Ventricular tachycardia

Discussion

Iatrogenic internal mammary artery and GCV anastomosis are rare complications during CABG surgery. Symptoms such as angina, dyspnea, fatigue, and palpitations may be related to non-revascularized arteries.[1] Ventricular tachycardia storms are rarely reported in the literature due to inadvertent anastomosis procedures.[1]

Ischemia and coronary steal syndrome are the two primary mechanisms underlying the pathophysiology of arteriovenous anastomosis. Several factors may increase the risk of iatrogenic inadvertent anastomosis, including pericardial adhesions from previous myocardial infarctions or reoperations, thick epicardial fat, and colorless cardioplegia solutions, which complicate the surgical exploration of the adjacent great cardiac vein. Transthoracic and transesophageal echocardiograms can define anatomy and detect changes without using ionizing radiation or contrast agents. Cardiac computed tomography and cardiac magnetic resonance imaging are the best non-invasive methods

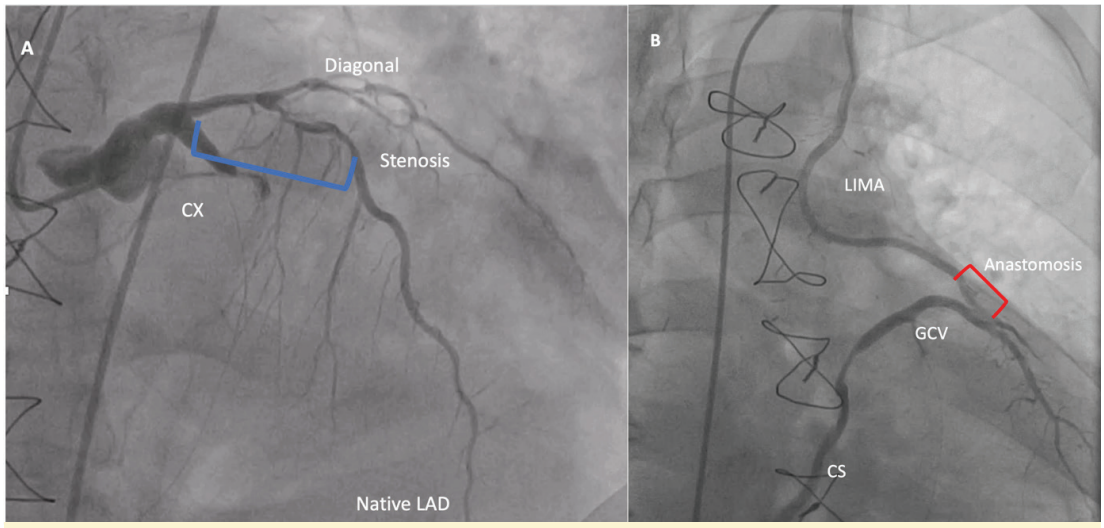

Figure 2. (A) Coronary angiography reveals proximal left anterior descending(LAD) artery stenosis (blue line) and proximal left circumflex (CX) artery occlusion, (B) Left internal mammary artery angiography showing that the left internal mammary artery (LIMA) was anastomosed to the great cardiac vein (GCV,). contrast drains into right atrium via coronary sinus (Red line) (Supplementary Video 1).

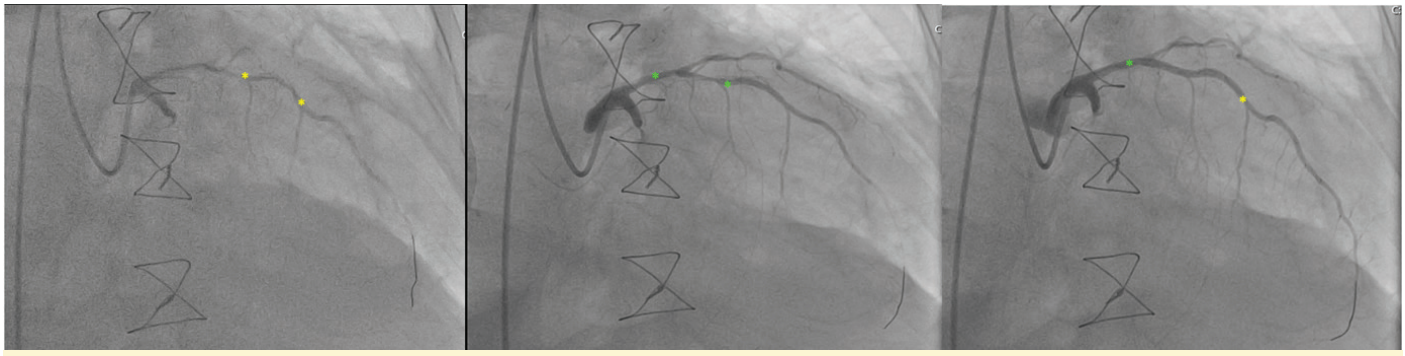

Figure 3. Native LAD revascularization: a 3.0x30 mm drug-eluting stent (DES) was implanted in the proximal lesion (green dots) and a 2.75x23 mm DES (yellow dots) in the distal lesion. TIMI 3 flow was observed in the LAD and diagonal region. (Supplementary Video 2).

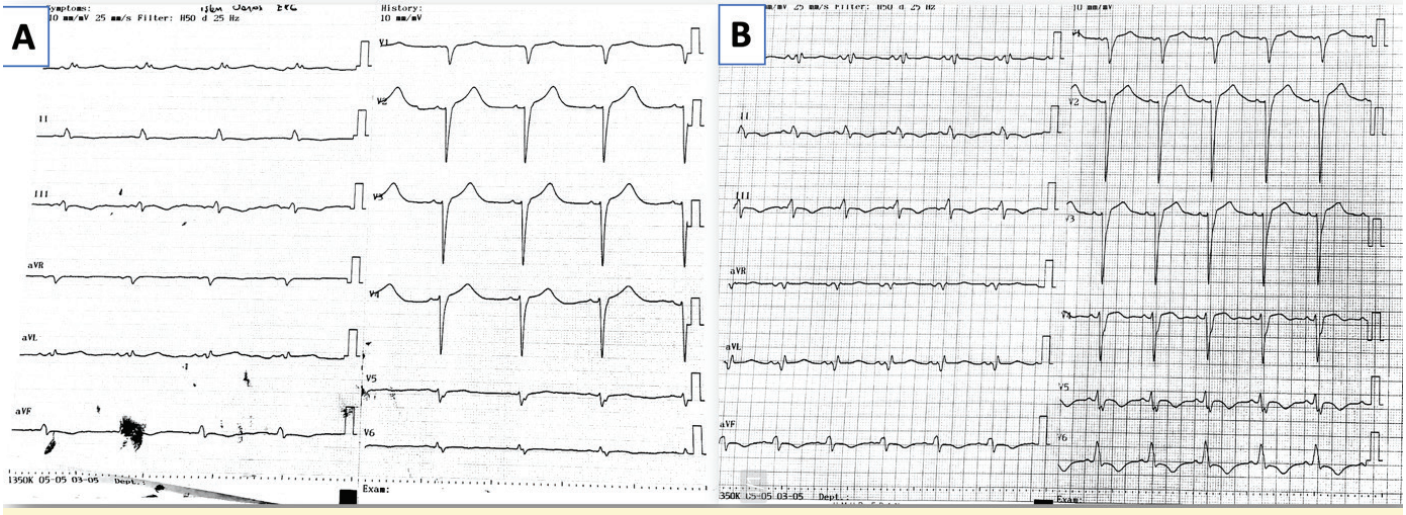

Figure 4. (A) After LAD revascularization ECG shows sinus rhythm and a QTc of 520 ms. (B) Discharge ECG reveals sinus rhythm and QTc 440 msn.

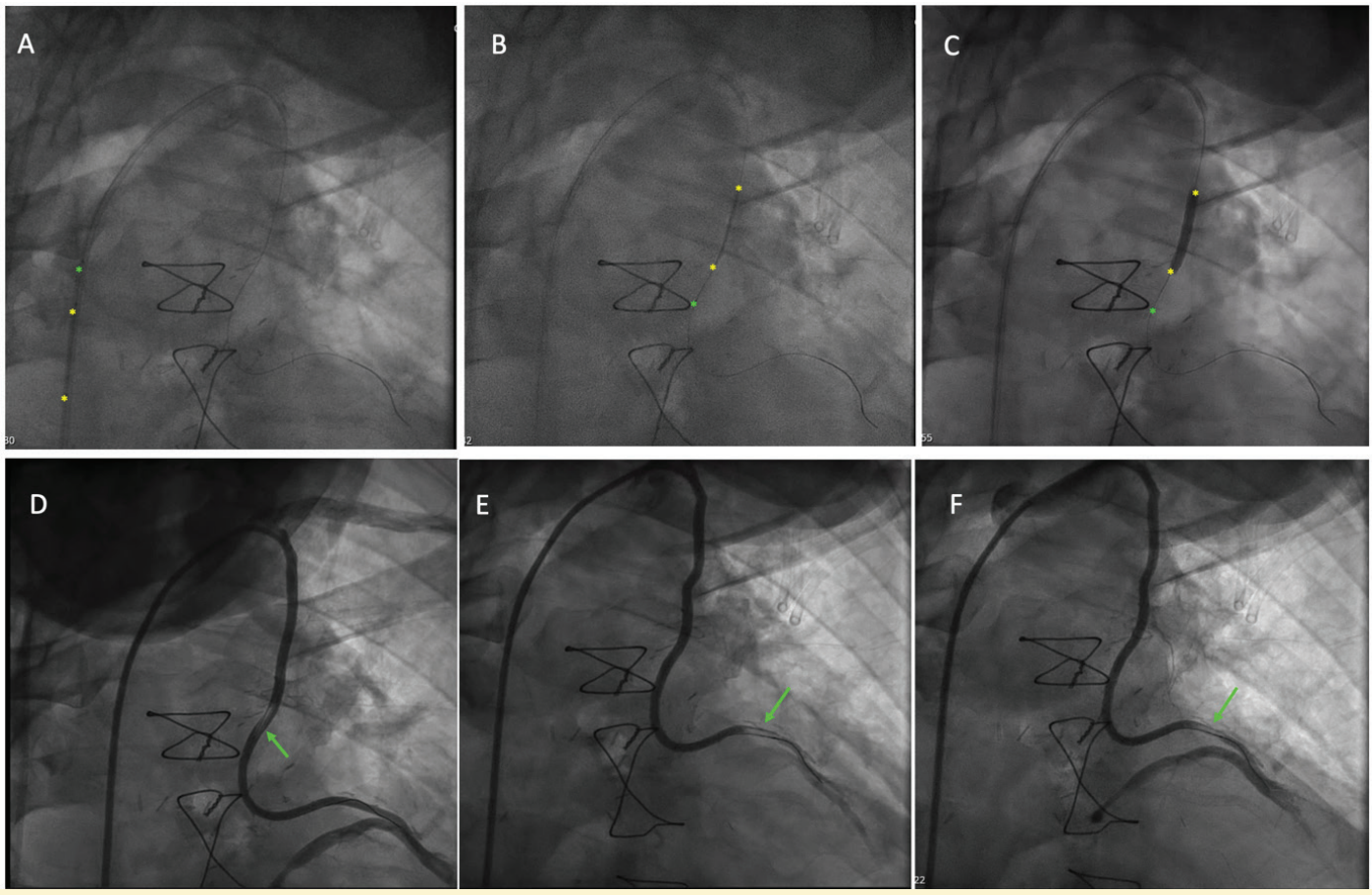

Figure 5. LIMA-GCV Anastomosis occlusion via Detachment balloon technique. (A-B) Balloon (green dot) and stent (yellow dot) advanced over the guidewire. (C) Deployment of the 3.0x23mm Firehawk® stent. (D-E-F) Balloon embolization and distal migration. (Supplement Video 4).

for diagnosing anastomosis.[2,3] Traditionally, selective invasive coronary angiography has been the gold standard for assessing anastomosis, facilitating both diagnosis and therapeutic embolization.

Cardiac surgery may expose patients with a substrate for ventricular arrhythmias to various arrhythmogenic triggers such as ischemia, reperfusion injury, hemodynamic changes, and electrolyte shifts, which may lead to postoperative ventricular arrhythmias (VAs). Postoperative VAs are associated with increased long-term mortality.[4] The management of postoperative sustained ventricular arrhythmias may be challenging due to the underlying mechanisms. Initial treatment of electrolyte imbalances and anti-arrhythmic drugs can address reversible causes. In our case, the patient was referred to our department for VT ablation due to a drug-resistant ventricular tachycardia storm. It is crucial to rule out ischemia in such cases, even if there are no anginal symptoms and biochemical parameters suggest otherwise. While catheter VT ablation is an effective treatment option,[5] especially for scar-related monomorphic ischemic VTs, assessing the precipitating substrate before ablation is important. The most indicative clue in this instance was the long QT and the polymorphic morphology of VT episodes observed on the admission ECG, suggesting ischemia. However, it was impossible to rule out acquired causes of QT prolongation due to the absence of previous ECG documentation. Underlying ischemic heart disease is the most common cause of ventricular tachycardia, which can manifest as either polymorphic or monomorphic. However, polymorphic VT and associated ventricular fibrillation (VF) are more common than monomorphic VTs in the early stages of acute coronary syndrome.[6] In acute ischemia, potassium leakage increases extracellular potassium levels, depolarizing myocytes in the ischemic zone.[7] This mechanism leads to electrical heterogeneity of cardiac tissue, providing a substrate for functional re-entry resulting in polymorphic VT. In contrast, monomorphic VT is typically a feature of myocardial scar re-entry.

Currently, there is no clear recommendation for managing iatrogenic LIMA-GCV anastomosis. Conservative management[1,5] is recommended for asymptomatic patients, but surgical and endovascular-based treatments[8] are described in the literature for symptomatic patients. Endovascular therapies generally aim to occlude the fistula and revascularize the responsible vessel through a percutaneous approach. Several occlusion techniques, such as coils,[9] detachable balloons,[10,11] and end-to-end covered stent implantation,[12,13] are documented in the literature. Treatment options should be tailored based on the characteristics of the fistula and vessel. In our case, LAD revascularization was initially performed. However, despite successful revascularization 48 hours post-procedure, the electrical storm persisted. The

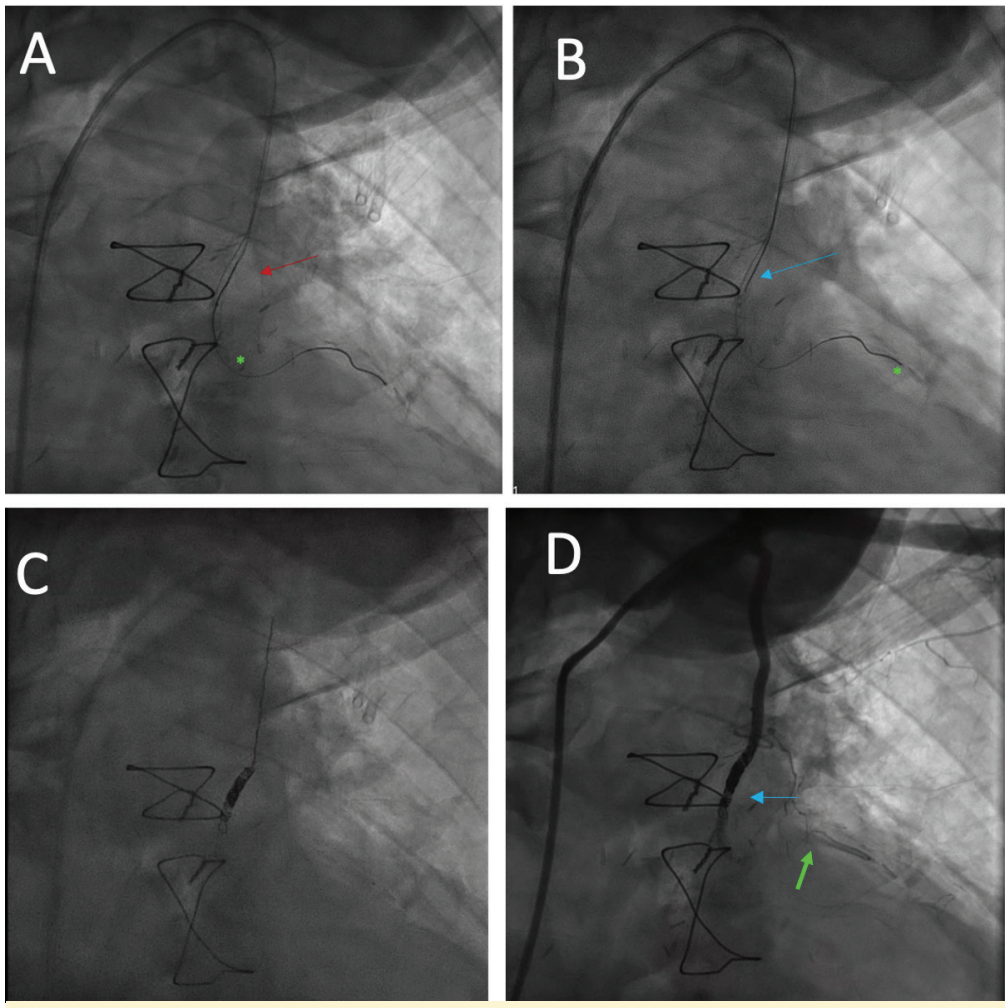

Figure 6. LIMA-GCV Anastomosis occlusion via Coil Embolization Technique (A) Placement of The Rebar® 027 microcatheter (red arrow) (B) Distal position of the balloon (green dot) (C) Two 5.0x20 mm Concerto™ coils placed (D) LIMA-CS anastomotic flow occlusion after coil embolization (blue arrow) and balloon embolization (green arrow). (Supplement Video 5).

mechanism underlying this condition may stem from an increase in coronary venous pressure and a decrease in perfusion pressure, which can occur due to a high-output arteriovenous fistula. This situation could potentially result in hemodynamic coronary steal syndrome, leading to persistent coronary ischemia. High-output fistulae may also elevate right heart pressures, causing heart failure and coronary venous rupture.[1] We opted for balloon detachment as the initial strategy for occlusion because this method is easily accessible, does not require a large-diameter catheter, and carries a lower risk of migrating to the native venous system. Although the balloon detachment technique reduced the flow, it failed to achieve complete occlusion. We successfully achieved complete occlusion of the fistula using coil embolization. If coil embolization proves unsuccessful, the retrograde covered stent technique may serve as an alternative solution. The diameter and dimensions of the coils selected must be compatible with the size of the vessel to ensure complete occlusion and minimize migration risk. We believe that the balloon detachment technique may reduce the risk associated with coil embolization. In cases of high-flow anastomoses, combined approaches should be considered, as demonstrated in our case.

Conclusion

The management of post-CABG ventricular arrhythmias should account for rare complications such as iatrogenic arteriovenous anastomosis. Advanced diagnostic techniques and a combination of interventional procedures, such as balloon detachment and coil embolization, prove effective in addressing these complications.

Informed Consent: The authors confirm that written consent for the submission and publication of this case, including images, was obtained from the patient in line with COPE guidance.

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Video 1. Native left coronary angiography and anastomosis between the left internal mammary artery (LIMA) and the great cardiac vein (GCV).

Video 2. Angiography of the right coronary artery and all saphenous vein grafts.

Video 3. Angiography of the native left anterior descending (LAD) artery post-revascularization.

Video 4. Occlusion of the LIMA-GCV anastomosis using the detachment balloon technique.

Video 5. Occlusion of the LIMA-GCV anastomosis using the coil embolization technique.

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