REVIEW ARTICLE

Catheter-induced Left Main Dissection: A Minefield in Interventional Cardiology

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Abstract

Coronary angiography is an invasive diagnostic procedure used to assess the coronary anatomy. Although rare, iatrogenic coronary artery dissection during coronary catheterization is a dreaded complication. Here we report the case of an 89-year-old patient diagnosed with acute coronary syndrome—Non-ST-segment elevation myocardial infarction, who underwent coronary angiography. During the coronary angiogram, he sustained a fatal left main coronary artery dissection. Here we discuss the interventions attempted to tackle the situation and a review of the approach to managing iatrogenic left main dissections.

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Introduction

One known side effect of cardiac catheterization is iatrogenic catheter-induced dissection of the left major coronary artery, which can cause sudden vascular closure, myocardial infarction, and death. A diagnostic or guiding catheter, as well as the insertion of interventional hardware, may result in an iatrogenic LM dissection. The process is thought to be brought on by damage to the artery wall during stenting, balloon dilatation, contrast media injection, or catheter or wire advancement.[1]

Emergent intervention is necessary for the majority of patients with this condition. Prior to 1993, when the first successful percutaneous bailout left major coronary artery (LMCA) stenting procedure was carried out, the preferred course of treatment was urgent coronary artery bypass surgery (CABG).

Since it can result in an abrupt stoppage of blood flow to a significant portion of the myocardium supplied by the left anterior descending (LAD) and left circumflex (LCx) arteries, many patients with left main dissection have a rapid decline in condition, and most of them worsen even before being moved for CABG. Heart arrest and pump failure follow from this. As shown in our example, prompt percutaneous coronary intervention (PCI) appears to be a suitable and practical substitute if carried out by a skilled interventionalist. There may be terrible repercussions if mechanical support is not received right away.

The major problem faced with iatrogenic artery dissection during diagnostic coronary angiograms is wiring the true lumen of the dissected arteries for stenting and the increased risk of perforation. Prevention is better than a cure. Therefore, taking the right measures before inserting the diagnostic/guide catheter into the coronary artery ostium helps avoid such disastrous outcomes.[2]

Case Description

An 89-year-old man arrived at the emergency room 2 hours prior to presentation, complaining of chest trouble. He was a known case of dilated cardiomyopathy with left bundle branch block (LBBB) who had undergone cardiac resynchronization therapy with defibrillator implantation in 2008, with pulse generator change twice in 2012 and 2018 because of the elective replacement indicator (ERI) of the pulse generator. On arrival, cardiac enzymes were elevated, and the ejection fraction was noted to be 35% with global hypokinesia of the left ventricle on echocardiography.

A coronary angiography was recommended for him, and a right radial access was acquired. The patient was diagnosed with arteria lusoria during the procedure, which made it difficult to enter the ascending aorta. Given the anatomical difficulty, the femoral approach was considered. Judkins right (JR) was used to cannulate the RCA, which was normal. The LMCA, which was cannulated, was accessed via the Judkins left (JL) route. After confirming the absence of dampening, contrast was injected. Unfortunately, the injection revealed contrast hanging in the LMCA with TIMI 0 flow to the LAD and TIMI 1 flow in LCx with a dissection flap from LMCA to LCx, suggesting coronary artery dissection in the LMCA occluding the LAD and spiral dissection in LCx (Fig. 1).

The patient complained of worsening chest pain, following which the ECG on the monitor showed ST elevations along with hemodynamic collapse. Immediately, the patient was put on inotropic, mechanical ventilatory, and intra-aortic balloon counterpulsation support. The wiring of the LCx and LAD true lumens was accomplished effectively. XIENCE Xpedition 3.5 × 48 mm was deployed in LCx, and SYNERGY stent 3.5 × 48 mm was deployed from the left main coronary artery to mid-LAD (Fig. 2).

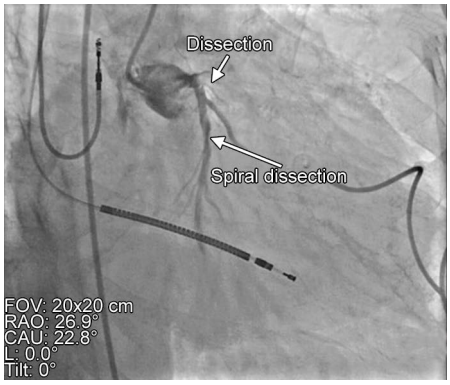

Fig. 1: RAO caudal view showing dissection of left main coronary artery (grade F) and spiral dissection (grade D) of left circumflex artery after contrast injection

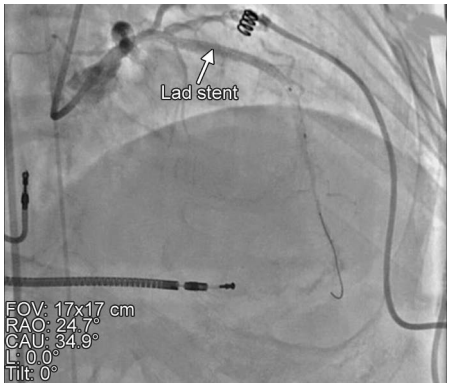

Fig. 2: RAO cranial view showing stent from left main coronary artery to mid Left anterior descending artery [LAD] and from mid to distal LAD

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Table 1: Studies on iatrogenic coronary artery dissection

Study	*No. of patients*	*Incidence (%)*	*Percutaneous coronary intervention (%)*	*CABG (%)*	*Conservative (%)*	*Mortality (%)*
Dunning et al. 2000[3]	9 out of 43,143	0.02	100			Nil
Lee et al. 2004[4]	10 out of 34,190	0.03	100			Nil
Eshtehardi et al. 2010[5]	38 out of 51,452	0.07	37	45	15	3
Cheng et al. 2008[6]	13 out of 18,400	0.071	84	7	9	
B Gryko A et al. 2021[7]	74 patients	0.06	100			
Raj et al. 2023[8]	3		IVUS guided PTCA 100			
Sumiyoshi et al. 2021[9]	1		Straw Technique			

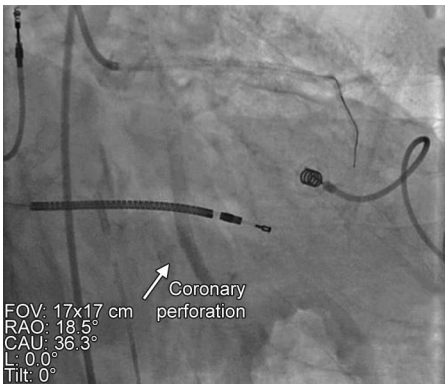

Fig. 3: RAO caudal view showing perforation of left circumflex artery (grade IV Ellis) after stenting of the left circumflex artery

However, stenting of the LCx led to a grade IV Ellis coronary artery perforation that led to pericardial tamponade and worsening of hemodynamic instability (Fig. 3). The patient underwent emergency pericardiocentesis, and 250 mL of hemorrhagic fluid was drained. A covered stent of size 4.0 × 19 mm was placed in the LCx that sealed off the perforation. Despite the above measures, the patient persisted to be in shock. He could not be resuscitated and succumbed shortly after the procedure.

Discussion

It has been estimated that the clinical incidence of coronary artery dissection caused by catheterization is less than 0.1%. It can be retrograde or antegrade. Risk factors include left main disease and calcification, use of an Amplatz catheter, catheter manipulation, vigorous contrast injection, deep intubation of the catheter, dilated aorta (too short Judkins), variant anatomy of the coronary ostium, and vigorous deep inspiration. The catheter should be appropriately sized, positioned, and coaxially aligned. It can be prevented by properly training the operator to look for pressure dampening before contrast injection and to avoid roofing the catheter into the vessel wall. Regarding the choice of arterial access site for cardiac catheterization, there is no difference between the transradial and transfemoral approaches. The right coronary artery has catheter-induced dissections 50% more often than the left major artery (45%). This is because type I collagen makes up the LMCA's sinotubular junction, whereas type III collagen makes up the RCA's. The tensile strength of type I collagen is higher than that of type III collagen. Variation in the angle of origin of the RCA from the aorta can also contribute to frequent dissection in the right coronary artery. Because it threatens a wide area downstream from the injury, iatrogenic LMCA dissection is an emergency, and its treatment is contingent upon the distal vessel's patency and the dissection's extent of propagation. PCI is currently the most common treatment method for iatrogenic LMCA dissection that results in ischemia. PCI avoids the CABG-related delays and can restore coronary patency, preventing prolonged ischemia, which is associated with a higher risk of myocardial infarction and death. This is especially crucial for patients who are hemodynamically unstable.[10]

Three forms of iatrogenic aortocoronary dissection (IACD) are included in Eshtehardi's simplified classification based on the extension of left main (LM) ostial dissection: type I—a localized dissection in the LM ostium, type II—extension of the dissection from the LM into the LAD artery or LCx artery, and type III—extension of the dissection flap into the aortic root. In this case series, hemodynamic instability was noted in 21 individuals with type I dissection (Table 1). Nevertheless, seven of the 17 patients with type II or III dissections (41%) experienced hemodynamic instability, and five of them (29%) required cardiopulmonary resuscitation.[5]

In catheter-induced coronary dissection, blood flows into the artery's subendothelial layers when the endothelial cell layer is disrupted, which is the process of damage. It causes an intramural hematoma to form in the false lumen, which can compress the actual lumen and result in ischemia. The magnitude of the dissection and the degree of antegrade blood flow determine the prognosis in these situations. With the exception of those with left main coronary artery stenosis of greater than 50% and impaired TIMI flow in vessels larger than 2.5 mm, minor dissections are treated conservatively. Stopping the contrast injection and thinking about IABP implantation is advised if dissection is identified. A soft-tipped wire should be advanced into the actual lumen as far as possible. Emergency CABG must be taken into consideration if many attempts fail to access the actual lumen. Since it helps us detect the actual lumen and the dissection flap in patients who are hemodynamically stable, intravascular ultrasound (IVUS) has been used extensively in coronary intervention and will play a significant role in managing this problem.[8]

Stenting distal to the proximal vessel must be taken into consideration when the actual lumen has been accessed. If there is retrograde propagation into the ascending aorta with hemodynamic instability, the patient should be posted for emergency CABG. If the patient is hemodynamically stable, ancillary imaging, such as computerized tomography, transesophageal echocardiography, and magnetic resonance imaging to define the extent of the dissection, must be considered, based on which the decision for either surgery or conservative management can be taken. Stenting dissected vessels carries a high risk of propagation of intramural hematoma and stent malapposition. During stenting, less aggressive pre- and postdilation must be considered in view of hematoma propagation, longer stents must be considered, and care must be taken to avoid oversizing the stents. Two methods can be followed if the true lumen cannot be wired in hemodynamically stable patients: the STRAW and STAR-R techniques. If accessing the actual lumen is challenging, the subintimal transcatheter withdrawal technique, or STRAW technique, is employed. The parallel wire and STRAW technique can be used with the help of a microcatheter in the false lumen to aspirate intramural hematoma and subsequently wire the true lumen.[9]

STAR-R (subintimal tracking and re-entry technique)—contrast-guided STAR-R is a feasible option for vessel revascularization. This method was previously applied to chronic complete occlusion. This has the disadvantage of loss of side branches. In order to produce tubular dissection and establish a link between the true and false lumen, this involves injecting contrast into the dissection plane (hydrodynamic recanalization). In case of failure of hydrodynamic recanalization, a guidewire can be advanced into the true lumen to create mechanical recanalization to facilitate wiring from the false to true lumen.[11]

Iatrogenic aorta coronary dissection is the term used to describe retrograde dissection of the aorta. Its incidence ranges from 0.04 to 0.12%. To better direct the treatment of this rare condition, Dunning et al.[3] created three categories of aortocoronary dissection in 2000: class I for focal dissection limited to the sinus of Valsalva; class II for dissection that propagated less than 40 mm to the ascending aorta; and class III for dissection extending 40 mm or more to the ascending aorta. These authors suggested surgical therapy for class III dissections and stenting of the dissection entrance point for class I and class II dissections. Nevertheless, there have been a few recent reports of class III IACD cases—including those involving the aortic arch—being effectively treated with early detection and quick coronary stenting to seal the entrance point.[12]

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