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"Kissing-Balloon" Angioplasty Associated Coronary Artery Perforation in Anterior STEMI: A Cautionary Tale

Iván Alfonso Vargas Moreno*[1], Mario Alberto Álvarez Rodríguez[2], Héctor Adrián Gámez Alvarado[2], José Eduardo Gómez Garay[2], Gerardo Ayala Almonte[2], Yoselin Esparza Monreal[2], Luis Delgado Leal[3], José Tomás Flores Flores[3], Cinthya Judith López Ramírez[4], Luis Rodrigo González Azuara[4], Federico García Soriano[5]

[1]Cardiology Resident. Centenario Hospital Miguel Hidalgo. Aguascalientes, México.

[2]Cardiology Resident. Centenario Hospital Miguel Hidalgo. Aguascalientes, México.

[3]Interventional Cardiologist. Centenario Hospital Miguel Hidalgo. Aguascalientes, México.

[4]Cardiologist. Centenario Hospital Miguel Hidalgo. Aguascalientes, México.

[5]Cardiothoracic Surgeon. Centenario Hospital Miguel Hidalgo. Aguascalientes, México.

ABSTRACT

Introduction: Bifurcation technique angioplasty remains one of the most challenging procedures in interventional cardiology, up to 10% of patient with STEMI present with a bifurcation as the culprit lesion. Coronary artery perforation is a known complication of percutaneous coronary intervention and complex coronary anatomy is often posed as a risk factor. Interventional and surgical management of coronary artery perforation is indicated as soon as possible.

Case presentation: A 55-year-old male was admitted to the emergency room with severe chest pain 12-hour prior to his admission. An anterior STEMI was diagnosed, and the patient underwent emergency coronary angiography with a bifurcation lesion of the mid LAD and D1, after transient loss of anterograde flow a secondary vessel a "kissing-balloon" technique was performed and type III coronary artery perforation in the Ellis classification of the side-branch was identified. Patient developed cardiogenic shock and urgent thoracotomy was performed. The patient was discharged in good conditions.

Conclusion: Coronary artery perforation is a feared complication of percutaneous coronary intervention. Chest pain and hemodynamic deterioration can quickly lead to patient's death. Identification as soon as possible and interventional or surgical management must be performed.

KEYWORDS: Coronary artery perforation, kissing-balloon, STEMI, bifurcation technique

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I. INTRODUCTION

Bifurcation technique angioplasty remains as one of the most challenging procedures in interventional cardiology and although the provisional stent technique is considered a first approach, most registries use stable ischemic heart disease data; the prevalence of bifurcation lesions in STEMI is approximately 10%[1]. In some studies, such as COBIS II registry[2] an increase in MACE, stent thrombosis and in-stent restenosis were found in the bifurcation group managed with a complex strategy; some conflicting data exists in the matter as other studies have found that strategies such as DK crushing, DK nano-crushing, inverted culotte and kissing-balloon can be used when the anterograde flow in the secondary vessel is compromised and the initial approach is no longer feasible.

Coronary artery perforation is a known complication of percutaneous coronary intervention and is usually caused by the migration of a coronary guidewire, balloon, or coronary stent, as well as by rotational atherectomy system into pericardial cavity or a cardiac chamber; it can quickly lead to cardiac tamponade, cardiogenic shock, and death of the patient[3]. Its incidence varies from 0.2 – 0.4% in non-complex lesions to 1.4 – 4.1% in chronic total occlusions, so the presence of angulated calcified type B2 and type C lesions, and long (>10 mm) eccentric lesions should be considered when performing coronary interventions [4].

Risk factors include complex coronary anatomy, use of stents or balloons larger than necessary, excessive post-dilation, and use of ablation devices or hydrophilic guides. Female gender, advanced patient age and previous coronary bypass are also considered relevant [5]. In some studies[6,7], it is considered that hydrophilic-coated guidewires could lead to the development of the condition, as the use of these is highly associated with intervention in chronic and complex lesions for their ease of distal migration.

Coronary perforations can be categorized based on severity of the perforation according to the Ellis Classification into three main classes (Table I) [8].

Table 1. Ellis Classification of Coronary Perforation

	Morphology	Clinical Sequelae
Type I	Extraluminal crater without extravasation	Almost always benign, treated effectively with stent placement
Type II	Pericardial or myocardial blush without contrast extravasation, <1 mm exit hole	Can result in late presentation of tamponade, requires close observation
Type III	Extravasation though frank perforation with >1 mm exit hole	High risk of tamponade, requires immediate treatment and often reversal of anticoagulation
Type III CS (Cavity spilling)	Perforation into anatomic chamber, such as coronary sinus, atria, or ventricles	Can have benign course, often results in fistulae formation

The diagnosis is characterized by sudden onset of acute and sharp chest pain or hemodynamic instability during balloon inflation or stent deployment. Although some of them can go unrecognized for longer if subtle. In case of pericardial effusion or cardiac tamponade hemodynamic deterioration and cardiogenic shock can quickly establish with need for further intervention in short time [9].

Echocardiography is recommended as soon as the perforation is identified and serially for as long as 48 hours afterward to assess for pericardial effusion or cardiac tamponade.

Management of coronary perforation depends on the patient's hemodynamic status and the site and severity of the perforation as it includes multiple therapeutic strategies, and as such it must be treated in the case-by-case basis[10].

II. CASE PRESENTATION

This is a 55-year-old male, with past medical history of smoking at a rate of 35 packs/year as the only known cardiovascular risk factor who was admitted to the emergency room due to severe retrosternal chest pain 12 hours before his admission. On initial evaluation his blood pressure was 117/82 mmHg and heart rate was 75 bpm. The initial electrocardiogram revealed sinus rhythm with ST-elevation > 2 mm in anterior leads (Figure 1), which led to an anterior STEMI diagnosis. The patient was loaded with aspirin (300 mg), clopidogrel (600 mg), and atorvastatin (80 mg) as well as 5 000 units of non-fractioned heparin and was emergently taken to the cardiac catheterization laboratory for urgent percutaneous coronary intervention.

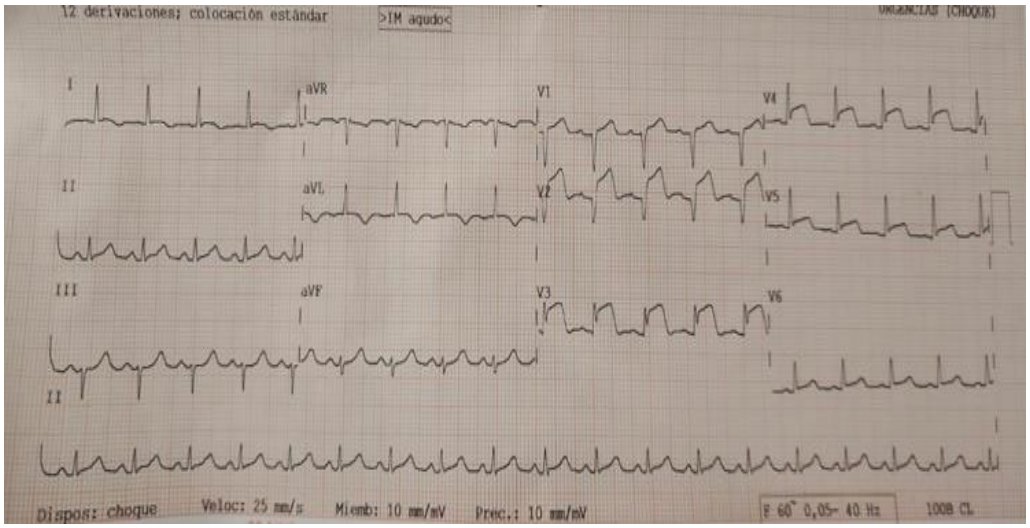

Figure 1. 12-lead electrocardiogram with ST elevation >2 mm in anterior leads

Diagnostic coronary angiography via the right radial artery was performed, and the culprit lesion was identified as a Medina 1-1-1 bifurcation involving an 80% non-calcified disease in the mid left anterior descending artery (LAD) and a 90% involvement of a large first diagonal branch (D1) (Figure 2).

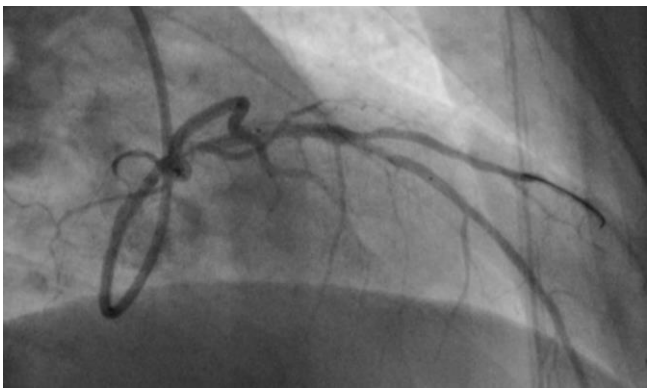

Figure 2. Right anterior cranial oblique coronary angiography with culprit lesion in bifurcation mid LAD and D1. Medina 1-1-1.

Hence the left main coronary artery was intubated with a 6 Fr M Radial catheter (Medtronic, USA) and two BMW 0.014"x190 cm coronary guidewires (Abbott, USA) were used to cross the lesion in the left anterior descending artery and the first diagonal branch, a direct Resolute Integrity 3.0x29 mm stent (Medtronic, USA) implantation at 14 atm for 21 seconds was performed distal to the first diagonal branch bifurcation, with a loss of anterograde flow into the side-branch, so provisional approach was discarded due to the vascular territory in jeopardy of the secondary vessel and a two vessel technique was chosen to preserve anterograde flow. Kissing balloon technique was then performed using an Euphora 3.5x15mm (LAD) and an Euphora 2.5x20 mm (D1) semi-compliant balloons (Medtronic, USA) inflated at 8 atm for 20 seconds (Figure 3), with angiography performed while both balloons were inflated to assess size discrepancy with the main vessel.

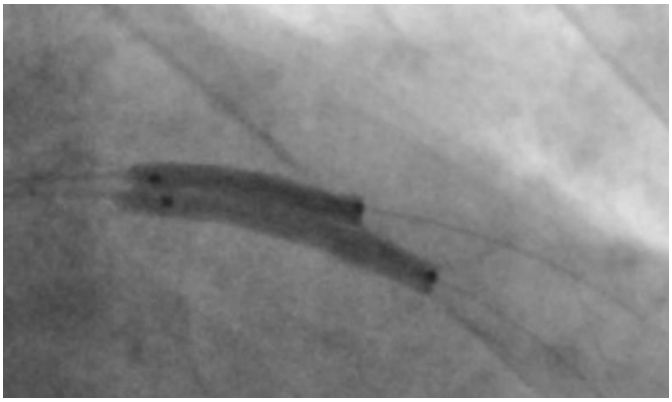

Figure 3. "Kissing-balloon" technique in mid LAD and D1 bifurcation with Euphora 3.5x15 mm and Euphora 2.5x20 mm balloons, respectively

In subsequent angiography coronary devices rejection into the aortic root as well as contrast extravasation into pericardium cavity of the first diagonal branch (Type III coronary perforation in the Ellis classification) were noted (Figure 4), initial management with prolonged (>10 minutes) balloon insufflation at 4 atm and reversal of heparin with 50 mg of Protamine was performed without achieving perforation closure. The patient developed cardiac tamponade with progressive hemodynamic deterioration and systolic pressure dropping to 40 mmHg, continuous dobutamine and norepinephrine infusions were initiated to control hemodynamic instability. Emergency pericardiocentesis was performed in the catheterization laboratory with initial aspiration of 60 mL of blood. Consulted cardiac surgeon, determined urgent thoracotomy due to hemodynamic instability.

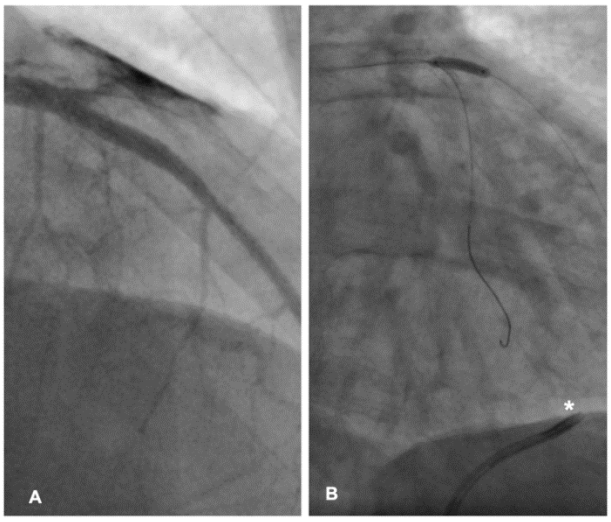

Figure 4. Right anterior cranial oblique coronary angiography with contrast extravasation into pericardial cavity (Type III coronary perforation in Ellis classification (A) and subsequent management with prolonged balloon insufflation and pericardiocentesis (*) (B)

Surgical findings revealed perforation of the first diagonal branch with exteriorization of the coronary guidewire and balloon (Figure 5), the gap was subsequently repaired with 5-0 Prolene suture and placement of Gelfoam patch. The patient was transferred to intensive cardiac care unit and was extubated within the hour. He was kept under surveillance for 5 days and was discharged after successfully completing phase II of cardiac rehabilitation. Outpatient follow-up with NYHA class II and without angina or dyspnea.

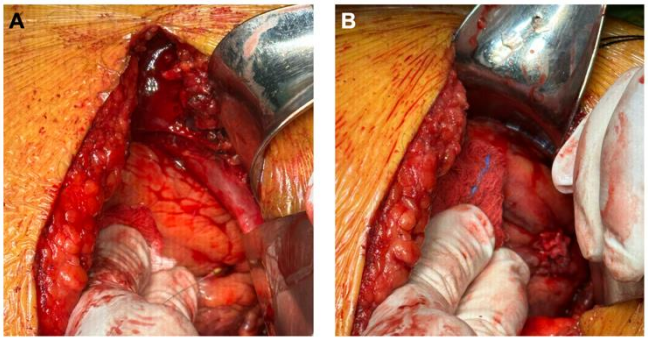

Figure 5. Anterior thoracotomy with perforation of the first diagonal branch and exposure of coronary guidewire and balloon (*) (A), and repair with Prolene suture and Gelfoam patch placement (B).

III. DISCUSSION

Bifurcation technique angioplasty represents a challenge for the cardiac intervention team, most of the literature is centered in the management of such lesions in the context of stable ischemic heart disease. A proper evaluation of angle, size and calcification is essential for maintaining anterograde flow in the main vessel as well as the side branch.

Bifurcation lesions are associated with high rates of procedural complications, incomplete revascularization, and adverse events such as stent thrombosis and in-stent restenosis especially when the setting of STEMI is considered.

Although provisional stenting remains as the main choice in the management of bifurcation lesions in STEMI, a two-stent technique is often needed if the anterograde flow is compromised in the side-branch and a large vascular territory is at risk.

Management of bifurcation lesions in the context of STEMI requires initial intervention of the main vessel with side-vessel intervention in case of loss of anterograde flow. Long term follow-up if often needed to assess myocardial ischemia in the event of compromise of the secondary vessel, while multiple studies such as the COBIS-II registry[2] suggest that a single stent approach reduces the rate of MACE, rates of re-intervention, unplanned vessel revascularization and improving long-term survival of the patient.

Coronary artery perforation is a serious complication of percutaneous coronary intervention, its particularly of interest in the setting of complex lesions and is often encountered in the setting of STEMI. The presence of chronic coronary lesions and severe calcification and angulation of coronary arteries make the presence of complications more likely because of distorted coronary anatomy, and the use of extra-support guidewires, hydrophilic guidewires, and coronary arterial remodelling devices such as rotational atherectomy which is often needed in the management of these lesions suppose an increased risk of perforation.

In the setting of coronary artery perforation patients may experience chest pain, hypotension, or signs of myocardial ischemia in case of anterograde blood flow is compromised.

Hemodynamic instability, electrocardiogram changes indicative of ischemia, and evidence of cardiac tamponade require immediate intervention and prompt cardiac surgery consultation.

Conservative management can be considered in case of small perforation if the patient remains stable. In cases of hemodynamic instability, a quick assessment through bedside echocardiography and emergent coronary angiography is recommended and immediate actions should take place once the perforation has been identified.

Management of coronary perforations includes long balloon insufflations, cloth o autologous fat embolization, coil delivered through microcatheters, and heparin reversal as initial management. In the management of large perforations covered stents play a major role, polytetrafluoroethylene (PTFE) covered stents are employed in the sealing of a coronary perforation with a layer impermeable to blood and have since reduced the number of emergency surgery as well as increasing the survival of the patients as an 85% success rate is reported in literature[11].

In case of a large perforation or significant bleeding which that cannot be controlled or poses a risk for patient's life, surgical repair is necessary.

VI. CONCLUSION

Coronary perforation is a known complication of percutaneous coronary intervention; its rapid onset requires immediate attention by the cardiac intervention team with assessment of the hemodynamic status of the patient and the myocardial area in risk. For its management, the operator experience, availability of equipment in the cardiac catheterization laboratory and resources such as covered stents and the patient general condition to undergo cardiac surgery should be considered.

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