Drug-eluting stent implantation in primary angioplasty of an anomalous left main coronary artery: diagnostic and technical considerations

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The presence of an anomalous origin and/or distribution of a coronary artery as the infarct-related vessel during primary angioplasty for acute myocardial infarction might represent a clinical and technical challenge. We report on a case of a patient with an acute anterior myocardial infarction who was referred to our hospital for primary angioplasty and whose culprit lesion was located on an aberrant left main coronary artery.

The purpose of this case report was to review the incidence and angiographic evaluation of an anomalous coronary vessel and to discuss the technical approach to an anomalous left main intervention and its impact on clinical outcome.

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Introduction

Coronary anomalies, once considered as rare medical curiosities, have assumed a new significance in the light of their reported associations with myocardial ischemia, infarction and sudden death.

We present a case of primary coronary intervention for acute myocardial infarction with an anomalous left main coronary artery (LMCA) as the infarct-related artery. The purpose of this case report was to review a method of angiographically evaluating the course of the anomalous vessel and to discuss the technical approach to an anomalous left main intervention.

Case report

A 57-year-old male, cigarette smoker, presented to a community hospital with persistent substernal chest heaviness lasting for 3 hours. On his arrival to the emergency room he suffered a cardiac arrest secondary to ventricular fibrillation and was successfully resuscitated with cardioversion and amiodarone. An electrocardiogram revealed a persistent ST-segment elevation in the antero-lateral leads. Intravenous unfractionated heparin, nitrates and amiodarone were administered and contin-ued and the patient was promptly referred to our hospital for primary angioplasty. The patient arrived to our cath lab 5 hours after the onset of symptoms. His blood pressure was 125/95 mmHg and his heart rate was 84 b/min.

At angiography, injection of contrast medium in the right sinus of Valsalva revealed a common ostium from which all coronary arteries arose (unique coronary artery). The right coronary artery coursed normally but was severely stenosed in its distal segment. An anomalous vessel arising from the proximal part of the right coronary artery was also evident. Super-selective engagement by means of a left Amplatz diagnostic catheter allowed us to demonstrate the presence of a distally sub-occluded anomalous LMCA as well as a severe narrowing of the proximal circumflex coronary artery (Fig. 1).

The diagnostic catheter was exchanged for a Vistabrite tip 8F left Amplatz guide catheter and the lesion of the left main was crossed with two 0.014" BMW guidewires (Guidant, Temecula, CA, USA), the first one positioned in the distal left anterior descending coronary artery and the second in the distal circumflex coronary artery. A 2.5 × 20 mm Maverick balloon (Boston Scientific, Natick, MA, USA), was inflated at 8 atm for left main predilation. The following
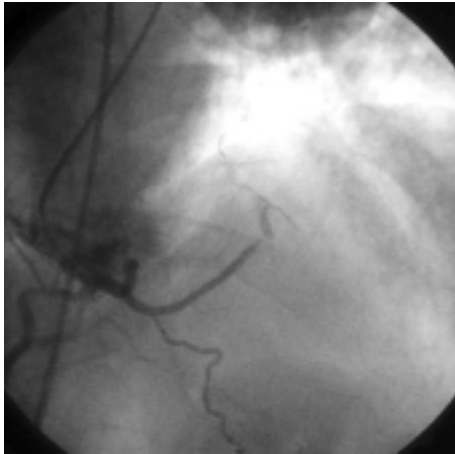
Figure 1. *Angiography of the suboccluded anomalous left main coronary artery in the 30° left anterior oblique, cranially angulated projection.*

Figure 2. A: *angiography of the anomalous left main coronary artery (LM) following stenting in the 30° right anterior oblique projection. B: diagram of the septal course of the anomalous left coronary artery. The LM and the circumflex coronary artery (CFX) form an ellipse (similar to the shape of an "eye"). LAD = left anterior descending coronary artery; RCA = right coronary artery; S= septal branch.*

angiographic control revealed the involvement of the left main distal bifurcation. A first 3.0 × 18 mm Cypher stent (Cordis, Miami, FL, USA) was deployed at 16 atm for 15 s to cover the lesion in the proximal circumflex coronary artery. A second 3.0 × 18 mm Cypher stent was deployed at 10 atm from the proximal left anterior descending coronary artery to the distal left main, with a jailed wire in the left circumflex artery. The wires were then exchanged: the first one was positioned in the left circumflex through the stent struts and the jailed wire in the circumflex was retrieved and advanced to the left anterior descending. The stent from the proximal left anterior descending to the left main was then overexpanded with a 3.5 × 20 mm Maverick balloon at 14 atm, the struts toward the left circumflex were opened with a 2.5 × 20 mm balloon and a final kissing balloon technique was performed at the distal left main bifurcation. The procedure was then completed by means of a third 3.0 × 18 mm Cypher stent which was deployed to completely cover the lesion on the left main shaft (culprit lesion). Postdilation of this stent at 20 atm was performed with a 3.5 × 15 mm Maverick balloon catheter with a good final angiographic result (Fig. 2A).

The patient's conditions improved immediately and by the end of the procedure his pain had subsided.

During coronary care unit observation the patient remained asymptomatic. The serum levels of the cardiac enzymes were increased, with maximal values of creatine kinase-MB and troponin I of 70 and 66 ng/ml respectively. An echocardiographic examination revealed only mild hypokinesia of the left ventricular antero-lateral wall and 7 days later the patient was discharged on aspirin, ticlopidine and propranolol. Clinical follow-up was event-free. The excellent angiographic outcome was confirmed 9 months later when the patient was readmitted for a planned follow-up angiography (Fig. 3).
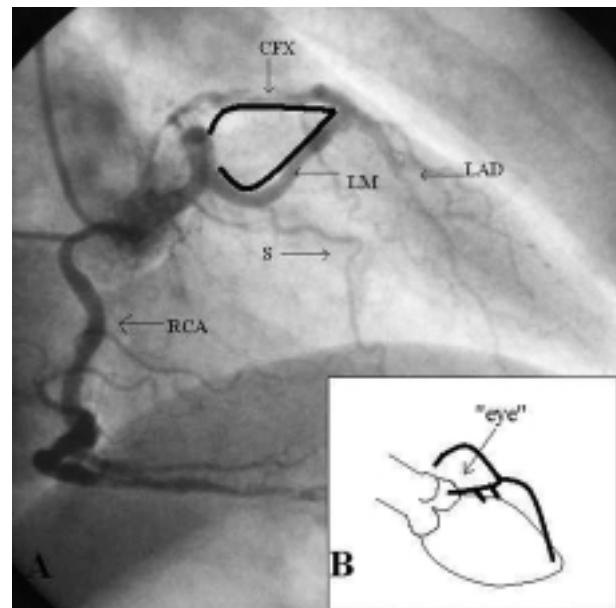

Figure 3. *Follow-up coronary angiography (shallow left anterior oblique, cranially angulated projection) obtained 9 months later: a good result with lack of restenosis is evident.*

Discussion

A 0.3% incidence of major coronary artery anomalies was reported in a large series of angiograms from the Coronary Artery Surgery Study[1]. In a more recent prospective angiographic study[2] including 1950 consecutive cases, which was performed according to clearly stated criteria and a strict classification scheme, the incidence of coronary anomalies was found to be 5.6%.

A single coronary artery is an exceedingly rare anomaly where only one coronary artery with a single

coronary ostium arises from the aortic trunk: it occurs in approximately 0.024-0.044%[3] of the population.

As the utilization of primary or rescue angioplasty becomes more frequent, anomalous coronary arteries are more likely to be encountered as the culprit infarct-related arteries and, as a matter of fact, quite a few percutaneous interventions of anomalous coronary arteries have been described[3-7], even very recently[8].

Since the natural history of and the most appropriate treatment for an anomalous origin of the coronary arteries depends not only on the severity of coronary artery disease but also on the initial course of the anomalous vessels, it is the angiographer's responsibility to accurately define the origin and course as well as the severity of coronary atherosclerosis in such vessels. This is usually a very challenging, complex and time-consuming procedure in cases observed so sporadically.

Five possible anatomical anomalies with a single coronary orifice in the right sinus of Valsalva and with different clinical implications are known:
• the left coronary artery crosses between the aorta and the pulmonary artery (interarterial, intertruncal). This anomaly has been associated with sudden death during or shortly after exercise in otherwise healthy subjects;
• the left coronary artery crosses anterior to the pulmonary infundibulum, in which the left coronary artery is a branch of the conus branch of the right coronary artery. Myocardial ischemia may occur, but is rare;
• the left coronary artery has a septal (intermuscular, subpulmonary) course within the crista supraventricularis and the ventricular septum. Several case reports have been reported with this anomaly but without any clinical significance;
• the left coronary artery crosses posterior to the atrioventricular valves. This is known as the most common course and has no clinical relevance.

The course of an anomalous coronary artery in relation to the great vessels may be inferred from its relationship to the pulmonary artery and coronary artery catheters in a left lateral projection, but this method may be difficult even for a cardiologist who is skilled in invasive procedures.

According to the "dot and eye" method, described by Serota et al.[9] in 1990, during a 30° right anterior oblique (RAO) projection, a "dot" representing the artery seen on the end is noted when the anomalous vessel courses posterior to the aorta. This is seen when the anomalous LMCA courses either posterior to the aortic root or between the aorta and the pulmonary artery. In the same projection, the anomalous LMCA and the initial portion of the left circumflex artery will form an eye-shaped ellipse to the left of the aorta when the LMCA and the initial portion of the circumflex artery assume an anterior route that takes the LMCA across the anterior right ventricular free wall or along the floor of the right ventricular outflow tract. The presence of this angiographic ellipse in the RAO view effectively rules out an interarterial (between the aorta and pulmonary artery) course of the anomalous LMCA. In our case we were able to assess that the anomalous vessel followed a septal course: in this (benign) pathway the left coronary artery runs an intramuscular course through the septum along the floor of the right ventricular outflow tract; it then surfaces in the mid septum, at which point it branches into the left anterior descending and the left circumflex artery.

During RAO coronary angiography (Fig. 2B) the left main and the circumflex coronary arteries will form an ellipse (similar to the shape of an eye) to the left of the aorta. The LMCA forms the inferior portion and the circumflex the superior portion. Moreover, septal perforating arteries are evident off the LMCA.

Since our patient presented with an atherosclerotic, subtotally occluded anomalous left main and an interarterial course of the same vessels could be ruled out, a primary percutaneous, coronary intervention was considered the treatment of choice.

Several considerations are relevant when deciding on the value of stent implantation in patients with an anomalous origin of a coronary artery from the opposite sinus of Valsalva:
1. the anomalous artery ostium is ectopic, usually juxta-commissural, and often difficult to reach with the guide catheter. Its proximal course is tangential to the aortic wall whether the normal arteries are oriented in an orthogonal plane or whether they are situated in the middle of the proper sinus of Valsalva;
2. both the circumference and the area of the proximal intramural segment of the anomalous vessel are smaller than those of the more distal "normal" (epicardial) artery. This feature leads to uncertainty regarding the ideal degree of stent dilatation. The risk of aortic dissection as a consequence of aggressive coronary dilation needs to be investigated;
3. at the intramural coronary segment no adventitia is present but only the aortic media and the inner elastic lamina. As a matter of fact, a previous case report[10] described the occurrence of moderate in-stent restenosis in this unusual environment.

In this case report we demonstrated that primary stenting can be performed in anomalous vessels with the use of conventional angioplasty equipment and technique and even with an acceptable door-to balloon time (45 min in our case).

A key determinant to proceed with percutaneous or surgical revascularization depends on the demonstration of the origin and course of the anomalous vessels: resorting to the "dot and eye" method may be useful in such cases.

To the best of our knowledge this is the first case in which a drug-eluting stent was implanted in an anomalous LMCA. We believe that the good immediate and long-term outcomes we observed in this case with no restenosis at follow-up angiography may encourage the use of stent angioplasty in these high-risk patients.

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