Double-barrel stenting of distal left main stenosis in a patient with acute coronary syndrome: Intravascular ultrasound and optical coherence tomography follow-up at six months

Anastasia Damelou MD, Periklis Davlouros MD, Vasileios Karantalis MD, Dimitrios Alexopoulos MD FACC FESC

A Damelou, P Davlouros, V Karantalis, D Alexopoulos. Double-barrel stenting of distal left main stenosis in a patient with acute coronary syndrome: Intravascular ultrasound and optical coherence tomography follow-up at six months. *Can J Cardiol* 2010;26(7):e282-e285.

A 58-year-old man presented with frequent episodes of angina at rest. A diagnosis of anterior non-ST elevation myocardial infarction was made. Coronary angiography performed on the day of admission revealed a significant stenosis (50% to 60%) of the distal left main stem (LMS) extending to the ostia of the left anterior descending and left circumflex arteries. Coronary artery bypass graft surgery was advised; however, the patient consistently declined this option. Kissing balloon predilation was performed at the LMS bifurcation, and two stents of the same diameter and length (4.0 mm × 18 mm) were simultaneously deployed at the same high pressure (18 atm) spanning the entire length of the LMS, and extending into the left anterior descending and left circumflex arteries beyond the bifurcation lesion. Six months later, intravascular ultrasound and optical coherence tomography revealed neointimal hyperplasia, especially in the artificial septum.

Key Words: Intravascular imaging; Left main coronary disease; PCI

A 58-year-old man with a history of dyslipidemia and hypertension presented with frequent episodes of angina at rest. An electrocardiogram showed ST segment depression in leads V₂ to V₅ and ischemic negative T waves (Figure 1A). Troponin I was elevated (0.68 µg/L). An echocardiogram revealed significant hypokinesia of the intraventricular septum and left ventricular anterior wall, with a left ventricular ejection fraction of 40%. Anterior non-ST elevation myocardial infarction was diagnosed, and coronary angiography performed on the day of admission revealed significant diameter stenosis (50% to 60%) of the distal left main stem (LMS) extending to the ostia of the left anterior descending (LAD) and left circumflex (LCx) arteries (Figure 1B). Quantitative coronary analysis (Xcelera R3.1L1, Philips Medical Systems, The Netherlands) measurements obtained at the ostia of the latter vessels revealed a minimum luminal diameter of 2.21 mm and 2.19 mm, and a minimum luminal surface area of 3.83 mm² and 3.8 mm², respectively. There was also a significant stenosis of the proximal LAD. The right coronary artery was non-dominant and without significant disease. Coronary artery bypass graft (CABG) surgery was advised; however, the patient consistently declined this option. A SYNTAX (SYnergy between percutaneous coronary intervention with TAXus and cardiac surgery) score of 21 was calculated and angioplasty (percutaneous coronary intervention [PCI]) of the LMS bifurcation and the proximal LAD was planned for

Une double endoprothèse pour une sténose coronarienne de la souche principale distale gauche chez un patient ayant un syndrome coronarien aigu : Le suivi par échographie intravasculaire et tomographie par cohérence optique au bout de six mois

Un homme de 58 ans a consulté à cause de fréquents épisodes d'angine au repos. Il a obtenu un diagnostic d'infarctus du myocarde sans élévation du segment ST. La coronarographie effectuée le jour de l'hospitalisation a révélé une sténose importante (50 % à 60 %) de la souche principale gauche (SPG) distale jusqu'aux orifices de l'artère interventriculaire antérieure et de l'artère auriculoventriculaire. Le médecin a conseillé un pontage aortocoronarien, mais le patient l'a refusé à répétition. On a procédé à une pré-dilatation simultanée à l'aide de deux ballonnets à la bifurcation de la SPG et déployé simultanément deux endoprothèses du même diamètre et de la même longueur (4,0 mm × 18 mm) à la même pression élevée (18 atm) sur toute la longueur de la SPG, qui se sont prolongées dans l'artère interventriculaire antérieure et l'artère auriculoventriculaire au-delà de la lésion de bifurcation. Six mois plus tard, l'échographie intravasculaire et la tomographie par cohérence optique ont révélé une hyperplasie néo-intimale, notamment dans la cloison artificielle.

the next day because the patient remained highly symptomatic despite optimal therapy. An intravascular ultrasound (IVUS; Volcano Therapeutics Inc, USA; automatic pullback rate of 0.5 mm/s) of the LMS was performed, which demonstrated a concentric area stenosis of 60% without significant calcification (Figure 2A). The measured lumen surface area was 15 mm², the minimum diameter was 3.2 mm and the maximum diameter was 5.4 mm. An intra-aortic balloon pump was placed prophylactically, and stenting of the proximal LAD lesion was performed with a XIENCE V 3.5 mm × 15 mm stent (Abbott Laboratories Ltd, Canada). A double-barrel stenting technique was chosen for the LMS bifurcation lesion due to the size of the vessel relative to the LAD and LCx artery sizes. Kissing balloon predilation was performed at the LMS bifurcation, and two stents of the same diameter and length (XIENCE 4.0 mm × 18 mm) were simultaneously deployed at the same high pressure (18 atm) spanning the whole length of the LMS and extending into the LAD and LCx arteries beyond the bifurcation lesion. A high-pressure postdilation procedure was performed with two noncompliant balloons (NC Mercury, Abbot Laboratories Ltd, Canada; 4.0 mm × 15 mm each) at 18 atm with a good angiographic result (Figure 3A). IVUS imaging was repeated to ensure adequate stent expansion and apposition, and absence of peristent dissection. Following PCI, lifelong acetylsalicylic acid (100 mg once a day) in addition to clopidogrel (150 mg once a

Cardiology Department, Patras University Hospital, Rion, Patras, Greece

Correspondence: Dr Anastasia Damelou, Patras University Hospital, Rion, Patras 26500, Greece. Telephone 30-261-0999281, fax 30-693-2468624,

e-mail ndamelou@hotmail.com

Received for publication November 16, 2009. Accepted February 11, 2010

Figure 1) A Electrocardiogram on admission, ST segment depression in leads V_2 to V_5 and ischemic negative T waves. **B** Coronary angiography (right anterior oblique caudal projection) disclosing the stenosis of the left main stem bifurcation (closed arrow) and proximal left anterior descending artery (open arrow). The intravascular ultrasound frame presented in Figure 2A was taken at the point proximal to the bifurcation (dotted line)

Figure 2) A Intravascular ultrasound imaging of the left main stem demonstrating a concentric stenosis of 60% without significant calcification. The luminal (white line) and vessel (yellow line) borders, and minimum and maximum diameters are also shown. **B** Intravascular ultrasound imaging of the stented segment of the left main stem just proximal to the bifurcation disclosing a double barrel created by the apposition of the two stents on one another (open arrow) and a triangular gap in the area outlined by the arterial lumen and outer surface of the two stents at the perimeter (white arrow)

day for six months and 75 mg thereafter) were prescribed. The patient remained asymptomatic, and two days after PCI, he was discharged from the hospital. Six months later, he was angina free and was readmitted for follow-up angiography. The angiography revealed a patent LMS, and LCx and LAD arteries with absence of significant restenosis (Figure 3B). IVUS imaging revealed mild intimal hyperplasia, two layers of stent struts within the central lumen of the LMS forming a new artificial septum, and a large triangular gap in the area outlined by the arterial lumen and outer surface of the two stents at the perimeter (Figure 2B). Optical coherence tomography (OCT, M2CV Imaging

System, LightLab Inc, USA; automatic pullback rate of 3 mm/s) was also performed, which revealed neointimal coverage of the stent struts, particularly at the artificial septum, with no indication of thrombus formation (Figure 4). A follow-up echocardiogram was performed, which revealed a left ventricular ejection fraction of 55% with only mild hypokinesia of the apex.

DISCUSSION

Bypass surgery is the treatment of choice for unprotected LMS disease. The latter is considered to be a class III indication for PCI, unless the

Figure 3) **A** Coronary angiography following stenting with abolishment of the left main stem and left anterior descending artery stenoses. **B** Follow-up coronary angiography demonstrating the absence of significant restenosis of the left main stem and left anterior descending artery stented segments compared with the initial post-percutaneous coronary intervention angiography

Figure 4) Optical coherence tomography imaging of the left main stem bifurcation from two different pullbacks – the left anterior descending artery (**A**) and the left circumflex artery (**B**) – disclosing the thin septum created by the struts of the two stents apposed on one another (arrows). The septum is covered by a thin neointimal layer

patient is not eligible for CABG, in which case, PCI has a class IIa indication. Recent results from the SYNTAX trial (1) showed no difference in one-year cardiac and total mortality between patients with LMS disease treated with CABG and those treated with PCI. Stenting of the LMS only, or the LMS plus one vessel, was actually favourable over CABG in terms of one-year events. Additionally, PCI was superior to CABG in patients with a total SYNTAX score lower than 22. However, patients with acute coronary syndromes were excluded in the SYNTAX trial. Therefore, SYNTAX scoring for clinical decision making applies only to patients with stable coronary artery disease,

and its relevance and usefulness in cases like the one described in the present report are not known.

PCI of LMS bifurcations is technically more challenging, and patients with distal LMS stenoses have a worse outcome than those with ostial and midshaft lesions (2). Although it seems that the technique used to treat bifurcations has a significant impact on clinical implications, the issue regarding the most appropriate one is still debated. The double-barrel technique is a simple and well-suited technique for the treatment of LMS bifurcation lesions because of size mismatch between the large vessel (LMS) and the two medium-sized vessels (LAD and

LCx) it bifurcated into. The technique involves the placement of two stents beginning from the LMS, and covering the ostia and proximal segments of the LAD and LCx, creating a double-barrel appearance within the LMS without any distortion of stent architecture, and with good angiographic results for both the LMS and side branch ostial stenoses. Using this technique in 30 patients with distal LMS disease, Morton et al (3) described good short- and medium-term angiographic and clinical results. However, the double-barrel technique has been criticized due to the new artificial septum that is created by the double stent layer, and the triangular gaps between the arterial lumen and the outer surface of the two stents, which may create conditions that are ideal for thrombus accumulation. Another disadvantage of the technique is the potential difficulty associated with future PCI of the LMS or LAD and LCx.

IVUS is the gold standard imaging technique for the assessment of luminal and vessel size, and is broadly used in unprotected LMS stenting before and after the procedure. It offers accurate measurement of vessel dimension and analysis of the vessel walls, and of the plaque and its components. Final IVUS imaging ensures adequate stent expansion, complete stent strut apposition to the vessel wall and absence of persistent dissection – features that are associated with restenosis, and acute or subacute thrombosis. OCT is a relatively new imaging modality with 10 times higher spatial resolution

compared with IVUS. A possible limitation of OCT application for LMS study could be the large diameter of the vessel, which may lead to suboptimal visualization of the arterial wall due to the low penetration of the technique.

CONCLUSION

The presented case suggests that OCT could be used when using the double-barrel technique for the evaluation of the final result after placement of LMS stents and, especially, at follow-up for the visualization of the two-layer septum, its endothelial coverage and the possibility of thrombus formation.

REFERENCES

1. Serruys PW, Morice MC, Kappetein AP, et al. Percutaneous coronary intervention versus coronary-artery bypass grafting for severe coronary artery disease. *N Engl J Med* 2009;360:961-72.
2. Chen SL, Ye F, Zhang JJ, et al. Distal left main coronary bifurcation lesions predict worse outcome in patients undergoing percutaneous implantation of drug-eluting stents: Results from the Drug-Eluting Stent for the Treatment of Left Main Disease (DISTAL) Study. *Cardiology* 2009;113:264-73.
3. Morton AC, Siotia A, Arnold ND, et al. Simultaneous kissing stent technique to treat left main bifurcation disease. *Catheter Cardiovasc Interv* 2007;69:209-15.