Published in final edited form as:

Int J Cardiol. 2018 March 01; 254: 84–86. doi:10.1016/j.ijcard.2017.11.105.

Effectiveness of new generation drug-eluting stents in ostial right coronary artery lesions

Matteo De Rosa^a and Gaetano Santulli^{a,b,*}

^aDepartment of Biomedical Advanced Sciences, “Federico II” University, Naples, Italy

^bDepartment of Medicine, Albert Einstein College of Medicine, Montefiore University Hospital, New York, NY, USA

Ostial coronary artery lesions [aorto-ostial lesions (AOLs), non-aorto-ostial lesions, and branch-ostial lesions] refer to a narrowing located within 3 mm of the coronary orifice. AOLs include ostial lesions of right coronary artery (RCA), left main coronary artery (LMCA), and venous grafts (Fig. 1A). The vast majority of AOLs encountered in clinical practice is due to atherosclerosis and is associated with diffuse coronary artery disease. Other causes include inflammatory aortic wall disease, mediastinal radiotherapy, prior surgery, congenital aortic hypoplasia, and extrinsic compression by a dilated pulmonary artery [1].

1. Diagnostic issues

Management of ostial lesions, especially those arising in the RCA, which occur in 1% of patients with angiographically defined coronary artery disease [2], has always posed several issues. A correct diagnosis is demanding since the lesion at the ostium can be missed if the catheter is deeply intubated into the coronary artery. Since non-selective injection of contrast media may cause suboptimal opacification of coronary artery, the cardiologist has to keep the catheter tip in coaxial position within the aortic root, proximal to the ostium.

Quantitative coronary angiography sometimes is unable to allow a careful assessment of the lesion due to the lack of a proximal reference segment. To offset such challenge, IVUS and FFR allow a proper anatomic and functional evaluation of the lesion.

2. Treatment of ostial RCA lesions

Treatment of ostial RCA lesions remains a major challenge. In the balloon angioplasty era, coronary angioplasty of the ostial RCA lesions revealed a relatively poor procedural success, high acute complication rate, high incidence of restenosis and other technical problems when compared with non-ostial lesions [2]. Clinical trials examining the use of adjunctive devices such as directional or rotational atherectomy, excimer laser, cutting balloons, or

*Corresponding author at: Department of Medicine, Albert Einstein College of Medicine, Montefiore University Hospital, New York, NY, USA and Department of Biomedical Advanced Sciences, “Federico II” University, Naples, Italy. gsantulli@gmail.com (G. Santulli).

Conflict of interest

The authors report no relationships that could be construed as a conflict of interest

debulking devices were inconclusive [3]. Introduction of bare metal stents (BMS) significantly improved the success rate and reduced the restenosis rate of AOLs, despite that they still had worse outcomes than non-AOLs [4]. Afterwards, several studies have evaluated the outcome of patients with AOLs treated with drug-eluting stents (DES) or BMS, showing a significant decrease in restenosis rate and target lesion revascularization (TLR) after DES implantation compared with BMS [5]. However, long-term follow up after DES implantation for ostial RCA lesions revealed that restenosis rate and early and late TLR were still unacceptable when compared to non-ostial RCA lesions [6].

Anatomical characteristics of AOLs may contribute to the unfavorable outcome of stenting procedure. Indeed, funnel-shaped morphology, extreme rigidity due to the high content of calcium and sclerotic fragments, increased resistance to dilatation and tendency to recoil due to the greater amount of muscular and elastic tissue in the adjacent aortic wall prevent accurate deployment of the stent in AOLs. However, introduction of new generation DES (nDES) [7] ameliorated the prognosis of ostial RCA lesions, significantly reducing TLR rate compared with early generation DES (eDES) [6].

An elegant Italian–Japanese study focused on ostial RCA lesions has demonstrated that nDES displayed a lower incidence at 3 years of TLR, target vessel infarction, and cardiac mortality compared with eDES [8] (Fig. 1B).

3. RCA vs LMCA ostial disease

Several studies reported a different outcome of DES implantation comparing RCA and LMCA ostial disease: LMCA ostial disease without concomitant bifurcation lesions display a favorable long-term outcome following DES implantation with very low restenosis and stent thrombosis risk [9]; conversely, a high risk of restenosis after DES implantation has been reported for ostial RCA lesions [10].

A difference in the distribution of the surrounding musculature in LMCA and RCA orifices might underlie such different outcome. Indeed, muscle bundles of the RCA arise independently of the elastin-muscle fibers of the aorta and frequently form a circumferential sphincter-like muscle frame. The ostium of LMCA contains instead elastin-muscle fibers similar to aortic ones. Besides, the adventitia is thicker in the ostial RCA than that in the LMCA ostium.

4. Procedural risks

Ostial stenting might trigger unique complications. The placement of the proximal stent edge outside the aorto-ostial landing zone, defined as the area located within 1 mm of the aorto-ostial plane, is known as geographic miss. Proximal geographic miss leads to protrusion of the stent into the aortic root, which may prevent future catheter access to the coronary artery; distal geographic miss, instead, increases the risk of restenosis by leaving part of the lesion uncovered by stent struts. During initial engagement and vessel wiring, the catheter may wedge within the lesion causing vessel closure and ischemia. This complication can be recognized by the presence of chest pain, dyspnea, diaphoresis, fall in systemic blood pressure and *damping* of pressure trace at the catheter tip. Longitudinal stent

deformation may be initiated by traumatic impact of the guiding catheter and stent struts. Furthermore, excessive instrumentation during deployment may lead to stent dislodgement and embolization and catheter guide wedging or excessive balloon inflation may cause dissection of the coronary artery and aortic root. Implantation of undersized stents, lower inflation pressures of balloon stent or a calcified ostium may underline incomplete stent expansion, resulting in excessive recoil and increasing the risk of restenosis.

5. How to overcome ostial lesion challenges

A proper guide catheter and guidewire selection is highly recommended. Less aggressive catheters (*e.g.* Judkins) are preferred to expedite disengagement avoiding wedging. For some ostial RCA lesions, a multipurpose guide may be chosen and wires with more support may be preferable. They should be preloaded into the guide catheter and quickly advanced into the coronary artery as soon as the ostium is engaged, preventing a catheter-induced ostial vasospasm. Improved imaging of the aorto-ostial plane may be performed to ensure an accurate assessment of the site, and reveal geographic miss or stent incomplete expansion. Indeed, the combination of multiple angiographic views in 2D angiography minimizes foreshortening or overlap. Incorporation of IVUS in the stent delivery system or hybrid intravascular imaging also contributes to an appropriate stent positioning. Balloon predilation is endorsed to reduce the rigidity of the lesion, and devices such as cutting balloon, rotablation, or rotational atherectomy can be considered. Unconventional techniques including Floating Guide Wire and Szabo, as well as Ostial Pro Device, Stent Boost, and self-expanding nitinol-based Cappella stent have been suggested to obtain an accurate stent positioning.

Acknowledgments

Dr. Santulli is supported by the NIH (DK107895).

References

1. Rissanen V. Occurrence of coronary ostial stenosis in a necropsy series of myocardial infarction, sudden death, and violent death. *Br Heart J*. 1975; 37:182–191. [PubMed: 123464]
2. Topol EJ, Ellis SG, Fishman J, Leimgruber P, Myler RK, Stertz SH, O'Neill WW, Douglas JS, Roubin GS, King SB 3rd. Multicenter study of percutaneous transluminal angioplasty for right coronary artery ostial stenosis. *J Am Coll Cardiol*. 1987; 9:1214–1218. [PubMed: 2953771]
3. Jain SP, Liu MW, Dean LS, Babu R, Goods CM, Yadav JS, Al-Shaibi KF, Mathur A, Iyer SS, Parks JM, Baxley WA, Roubin GS. Comparison of balloon angioplasty versus debulking devices versus stenting in right coronary ostial lesions. *Am J Cardiol*. 1997; 79:1334–1338. [PubMed: 9165153]
4. Hoffmann R, Mintz GS, Mehran R, Pichard AD, Kent KM, Satler LF, Popma JJ, Wu H, Leon MB. Intravascular ultrasound predictors of angiographic restenosis in lesions treated with Palmaz–Schatz stents. *J Am Coll Cardiol*. 1998; 31:43–49. [PubMed: 9426016]
5. Al-Lamee R, Ielasi A, Latib A, Godino C, Mussardo M, Arioli F, Figini F, Piraino D, Carlino M, Montorfano M, Chieffo A, Colombo A. Comparison of long-term clinical and angiographic outcomes following implantation of bare metal stents and drug-eluting stents in aorto-ostial lesions. *Am J Cardiol*. 2011; 108:1055–1060. [PubMed: 21791332]
6. Sugihara R, Ueda Y, Nishimoto Y, Takahashi K, Murakami A, Ueno K, Takeda Y, Hirata A, Kashiwase K, Higuchi Y, Yasumura Y. Outcomes of first- versus second-generation drug-eluting stent implanted for right coronary artery ostial narrowing. *Am J Cardiol*. 2017; 119:852–855. [PubMed: 28073430]

7. Santulli G. microRNAs distinctively regulate vascular smooth muscle and endothelial cells: functional implications in angiogenesis, atherosclerosis, and in-stent restenosis. *Adv Exp Med Biol.* 2015; 887:53–77. [PubMed: 26662986]
8. Mitomo S, Jabbour R, Watanabe MA, Mangieri A, Ancona M, Regazzoli D, Tanaka A, Nakajima A, Naganuma T, Giannini F, Latib A, Nakamura S, Colombo A. Comparison of mid-term clinical outcomes after treatment of ostial right coronary artery lesions with early and new generation drug-eluting stents: insights from an international multicenter registry. *Int J Cardiol.* 2018; 254:53–58. [PubMed: 29407132]
9. Chieffo A, Park SJ, Valgimigli M, Kim YH, Daemen J, Sheiban I, Truffa A, Montorfano M, Airolidi F, Sangiorgi G, Carlino M, Michev I, Lee CW, Hong MK, Park SW, Moretti C, Bonizzoni E, Rogacka R, Serruys PW, Colombo A. Favorable long-term outcome after drug-eluting stent implantation in nonbifurcation lesions that involve unprotected left main coronary artery: a multicenter registry. *Circulation.* 2007; 116:158–162. [PubMed: 17576862]
10. Ko E, Natsuaki M, Toyofuku M, Morimoto T, Matsumura Y, Oi M, Motohashi Y, Takahashi K, Kawase Y, Tanaka M, Kitada M, Yuzuki Y, Tamura T, Inoue K, Mitsudo K, Kimura T. Sirolimus-eluting stent implantation for ostial right coronary artery lesions: five-year outcomes from the j-Cypher registry. *Cardiovasc Interv Ther.* 2014; 29:200–208. [PubMed: 24390936]

Fig. 1.

Aorto-ostial lesions and stenting. A) Aorto-ostial and non-aorto-ostial lesions; RCA: right coronary artery; LMCA: left main coronary artery; SVG: saphenous vein graft; LAD: left anterior descending (coronary artery); Cx: circumflex (coronary artery). B) The cumulative rate of target lesion failure (TLF) 3 years after stenting aorto-ostial RCA lesions was significantly higher in the early generation drug-eluting stents (eDES) group when compared with the new generation (nDES) group ($*p < 0.001$). TLF was defined as composite of cardiac mortality, target vessel myocardial infarction, and target lesion revascularization; eDES included Cypher (sirolimus) and Taxus (paclitaxel) whereas nDES included Xience (everolimus), Promus (everolimus), and Nobori (biolimus).