Stent treatment of coronary artery bifurcation lesions

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This editorial refers to 'The clinical outcome of percutaneous treatment of bifurcation lesions in multi-vessel coronary artery disease with the sirolimus-eluting stent: insights from the Arterial Revascularization Therapies Study Part II (ARTS II)'† by Tsuchida et al., on page 433

In percutaneous coronary interventions (PCIs), the treatment of bifurcation lesions is a challenge to the interventional cardiologist. PCI operators, in general, use the term coronary artery bifurcation (from latin furca = fork, branch): (i) when a coronary artery divides into two equally important branches or (ii) when a main branch gives away a side branch, which is large enough to be of haemodynamic significance, whereas when a large coronary artery gives away a small, haemodynamically unimportant side branch, the term bifurcation is less used.

There is no consensus on when to use the term bifurcation lesion. Some PCI operators use this term for any lesion in or near a bifurcation, regardless they might be able to successfully stent the lesion using one wire and one stent only, whereas others reserve the term bifurcation lesion for complex lesions requiring two wires and intervention of both distal branches. The risk of PCI in different anatomical subsets has been identified in the American College of Cardiology/American Heart Association Guidelines since many years. However, lesion classifications based on severity of characteristics proposed in the past have been principally altered by the present PCI techniques.

A number of well-known technical and clinical problems are associated with bifurcation PCI, dependent on the anatomy, the lesions, and on the technique used. Important concerns are (i) plaque shift causing flow problems, (ii) wire trapping and subsequent need of wire replacement, (iii) stent deformation, (iv) stent overlap and large metal burden in the arteries, (v) incomplete lesion coverage, (vi) subacute stent thrombosis, and (vii) restenosis.

To overcome some of these problems, several specially designed bifurcation stent devices have been constructed. However, none of these have—so far—been tested in randomized comparisons with conventional stents. An interesting bifurcation device principle is a self-expandable nitinol device (DEVAX AXXESS), which when deployed proximal to the bifurcation and combined with distal kissing stenting with overlap leads to complete stent coverage of the bifurcation. Such a device would certainly be more useful if it had two wires inside the self-expandable stent in order to avoid wire trapping/replacement, although self-expandable stents have so far come to a limited use in PCI. Self-expandable stents are difficult to deploy with precision. Also, this type of stent is difficult to size. If oversized, they might cause a continuous trauma to the vessel wall. Therefore, long-term follow-up data and assessment of restenosis rates are needed.

In everyday clinical practice of bifurcation lesion treatment, conventional stents are used most often. A pragmatic, and presently much used, approach to bifurcation PCI is represented by the provisional side-branch stenting approach. In this approach, a single stent is deployed in the main or most diseased branch and one distal branch is 'jailed'. If/when the unstented jailed branch closes because of dissections or plaque shift, an attempt to recanalize the closed branch with subsequent stenting between stent struts might be successful. When the side branch is stented, the technique is called provisional T-stenting. Recanalization of an acutely occluded and jailed branch is probably more often successful when two wires are used initially, when there is limited disease in the ostium of the jailed branch, and/or when the operator is very experienced/skilled. There is no consensus on when to stent a stenosed side branch, which does not cause acute haemodynamic problems.

In cases with involvement of both the distal branches only, the so-called V-stenting or simultaneous kissing stent technique might be useful. In this technique, the two stents are most often deployed, with a minimal overlap. If there is proximal disease, this might be covered with a greater overlap, although this will create a double lumen. Furthermore, when this technique is used, there are no good solutions if a proximal dissection is caused. The long-term results of V-stenting with drug-eluting stents need further study.

For cases of more severe bifurcation disease involving the main branch and both distal branches, the technically difficult culotte technique and the crush technique have been proposed. These techniques depend on repositioning of a wire between struts and successive balloon dilatation.
which lead to considerable deformation of the stent. Long-term data on the importance of the stent deformation for subacute stent thrombosis and restenosis are scarce. 4,5

We recently reported promising preliminary results of a novel technique for PCI in coronary artery bifurcation lesions intended for severe bifurcation disease involving both the proximal segment and both distal branches. 6 This technique relies on two wires and conventional stent systems and seems to overcome many of the problems with previously known techniques for bifurcation PCI. The main feature of the new technique is the initial implantation of a stent proximally and close to the bifurcation. Thereafter, we stent the bifurcation with overlapping kissing stents. This will cover the entire bifurcation, securing access to the distal branches. We have presently studied the acute and 6 months angiographic and clinical results of this technique, in bifurcations that show disease of both the main branch and the two ostia of the distal branches, in 55 patients using sirolimus and paclitaxel-eluting stents and found low restenosis rate in both main and distal branches. Only one of these patients has had a subacute stent thrombosis located in the side-branch stent (unpublished data).

The introduction of drug-eluting stents has significantly reduced the restenosis problem in bifurcation lesions. In the SCANDSTENT trial, a randomized comparison of sirolimus-eluting and bare metal stents in complex lesions, there was a highly significant reduction of late lumen loss and restenosis in the sirolimus-eluting stent group. 7 In a sub-group study of bifurcation lesions, the angiographic late lumen loss in the main branch and the side branch was significantly reduced in the sirolimus-eluting stent group. Angiographic restenoses rates were 28.3 and 4.9% in the main and 43.4 and 14.8% in the side branches, respectively. Interestingly, in this study of bifurcation lesions, there were no subacute stent thromboses at 6-month follow-up in the sirolimus-eluting stent group (Am. Heart. J. Accepted).

Tuchida et al. presented a post hoc subgroup analysis of the 607 patients from the ARTS II register. 8 Patients had multivessel disease and were treated with sirolimus-eluting stents. Tsuchida et al. found a rate of 13% major adverse cardiac and cerebral events at 1 year clinical follow-up in the 324 patients with at least one bifurcation lesion. However, there was no influence of the presence of bifurcation morphologies on major adverse cardiac and cerebral events when compared with patients without bifurcation lesions. In a further more extreme post hoc subgroup analyses, the authors divide the subjects into patients with ‘true’ (200 patients) or ‘partial’ (124 patients) bifurcation lesion morphology and further into patients who received either one stent (263 patients) or two stents (61 patients). Also, in these analyses, there were no significant differences between the groups. It is well known that this kind of post hoc subgroup analyses should be evaluated with extreme caution. However, the study addresses an important question, which is the importance of classification of bifurcation lesion morphology and the related different treatment modalities. These are important matters in the future, if we, in prospective and randomized studies, are going to compare results of different treatment modalities and devices in different lesion morphologies.

Descriptive morphology classifications of atherosclerotic bifurcation lesions/stenoses have been proposed. 9,10 A morphology classification should, to be of real value to the interventional cardiologist, give guidance to treatment. Such a clinically relevant classification, based on the angiogram, should optimally lead the operator directly to one or more appropriate stenting techniques or devices.

However, there are a number of problems. The available projections of an angiogram do not always optimally demonstrate the true anatomy, for example, the true angulation between a main and a side branch. Severe atheromatosis, which does not cause significant stenoses, might not be visible in the angiogram but might be of importance in relation to plaque shift, dissection, and so on. The haemodynamic importance of a side branch is related to the amount of myocardium it supplies, although this is sometimes difficult to appreciate from the diameter and length of the side branch.

We propose to move forward and consider a more systematic and scientific approach to the study of bifurcation lesion treatment. Conventional stents or special devices need to be compared in different but well-defined lesion morphologies.

There are at least three different morphologies that call for prospective randomized studies comparing techniques and/or devices: (i) the lesion morphology with no or minor side-branch disease, in which the proposed treatment presently is stenting of the main branch with conventional drug-eluting stents, and side-branch treatment, if significant plaque shift or dissection; (ii) the lesion morphology with no proximal common trunk disease and significant disease of both distal legs, in which the chosen treatment presently often is simultaneous kissing stenting of both distal legs; and finally (iii) the true bifurcation lesion morphology with significant disease of the common main trunk and of both the distal branches, in which it is necessary to cover all three ‘legs’ with drug-eluting stents using techniques such as crush, culotte, or the Y.

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References


Clinical vignette
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Three overlapping septal occlusion devices to treat residual shunting across an atrial septal defect

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A 46-year-old woman with a history of non-ischaemic cardiomyopathy, severe biventricular failure treated with implantable cardiac defibrillator, presented with increasing dyspnoea. She also has a history of diffuse scleroderma and a prior percutaneous closure of an atrial septal defect (ASD).

Her ASD was closed in June 2004 with a 12 mm Amplatzer ASD closure device (Panel A). Two months later, recurrent right-to-left shunting was confirmed by transoesophageal echocardiogram (TEE) (Panel B) and haemodynamic evaluation. The shunt was treated with a second 15 mm Amplatzer ASD closure device (Panel C). Twenty-four hours after procedure, her SpO₂ was 96%. A follow-up TEE performed 8 months after the second device implantation again showed right-to-left shunt (Panel D). The patient was treated medically.

One year later, she presented again with worsening dyspnoea associated with decreased oxygen saturation. Because of her co-morbidities, the patient was deemed a poor candidate for surgery. The shunt was closed with a 25 mm patent foramen ovale (PFO) Amplatzer device (Panel E). Post-procedural angiography and TEE confirmed the presence of a well-seated device with no residual shunt (Panel F). Twenty-four hours later, her SpO₂ was 98%. Three months after the final procedure, a transthoracic echocardiogram showed well-seated devices and no interatrial shunting; her SpO₂ was 99%. To the best of our knowledge, this is the first published report of three sequential devices implanted to close recurrent shunting across an ASD.

Panel A. LAO 30°, cranial 30° view of the first implanted ASD closure device.
Panel B. TEE showing interatrial shunting through the first device.
Panel C. LAO 30°, cranial 30° view of the two implanted devices.
Panel D. TEE showing residual interatrial shunting after implantation of second device.
Panel E. LAO 30°, cranial 30° view of the three implanted devices.
Panel F. TEE with agitated saline showing absence of residual shunting after implantation of the third closure device.