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Editorial Comment

Bifurcational Lesions and the "Crush" Technique: Understanding Why It Works and Why It Doesn't—A Kiss Is Not Just a Kiss

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In most fields—and interventional cardiology is certainly among them—very few innovations proved fully effective as originally proposed: a number of refinements were needed to improve the performance. Another important caveat is that any innovation is only effective until something better is found.

Percutaneous treatment of coronary bifurcations is a typical area where these two concepts are put into play. Before going into more details, we should be aware that while provisional stenting of the side branch is a practical and effective technique in many bifurcations [1,2], there are a number of them where usage of two stents is needed. Therefore, we are in search of the optimal technique for that group of lesions.

When bare metal stents were the only type of stents available, we became aware that, even if sometimes needed, the implantation of two stents at a bifurcation was associated with all of the followings: technical difficulties, high periprocedural events, and 47.7% risk of restenosis [3]. The message was to do everything possible and acceptable not to implant a stent at the origin of the side branch. The counterpart of this suggestion was a major limitation for the treatment of unprotected distal left main lesions, a situation where usage of two stents is frequently needed.

The introduction of drug-eluting stents and specifically of the Cypher stent (Cordis, Warren, NJ) revitalized this field. In particular, the results of the Randomized Study to Evaluate Sirolimus-Eluting Stents Implanted at Coronary Bifurcation Lesions [4] showed that the 28% angiographic restenosis detected when two stents were implanted was a clear step forward compared to prior experience with bare metal stents. In addition, the fact that restenosis was most of the times focal and occurred mainly at the ostium of the side branch brought hopes for improvements. In that study, the technique utilized to perform double stenting was the T-technique. The frequent occurrence of restenosis at the ostium of the side branch and the utilization of the T-technique, known to leave a small gap between the main-branch and the side-branch stent, suggested that incomplete coverage with no drug delivered at the ostium of the side branch was a possible factor contributing to restenosis. A search was then started for an approach (in the absence of a specifically designed and friendly deliverable drug-eluting stent to treat the main branch and the side branch) able to give complete coverage of the ostium of the side branch. Among the techniques already available, the V-technique or kissing stent technique was known and in use as the most effective and practical approach to give full coverage of the bifurcation [5]. A limitation of the kissing stent technique is that it can only optimally be applied to bifurcations where the disease is confined to the bifurcation site with minimal extension in the proximal main branch [5].

At this point came the crush: an approach justified by the need to cover the origin of the side branch fully [6]. The main advantage of the crush technique was its relative simplicity with immediate patency of the two branches. The acceptable angiographic results obtained and the complexity to recross and dilate the stents toward the side branch did not initially support the recommendation to perform a second dilation into the side branch and a final kissing balloon inflation. Angiographic follow-up showed that despite apparent good coverage of the side branch, restenosis at the ostium of the side branch was still present in over 30% of the cases.

This unique and well-conducted study by Ormiston et al. [7] gives us understanding about side-branch stenting and about the downside of the crush technique if the final kiss is not performed and more importantly if it is not correctly performed. A limitation to be acknowledged from the beginning is that even following the implementation of the best technique, including appropriate final postdilatation, the side branch may still be incompletely stented. It is conceivable to assume that sometimes the stent struts may not exactly spread to cover the ostium of the side branch. This problem may be more frequent

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when the size of the side branch is very small relatively to the size of the stent cells which with the current stent design are quite large due to the need to encompass diameters between 2.25–3.0 mm (for the Cypher stent) and 3.5 mm (for the Taxus stent). In addition, when we go to an in vivo situation, we may face a fibrotic and poorly dilatable side branch, which may cause stent underexpansion and even stent recoil despite appropriate technique. We should dismiss that the shear stress distribution at lesions located at a bifurcation may be such that cell and matrix growth may be so enhanced to require stronger antiproliferative actions, a situation that cannot be always fully controlled by simple mechanical solutions.

Ormiston et al. [7] performed in vitro studies utilizing two models, one with an acute angle, the other with a more open angle between the main branch and the side branch. In the two models studied, it is important to appreciate the value to perform a correct postdilatation toward the side branch when the angle between the main and the side branch is more open (closer to 90°). What the authors demonstrate is that a fundamental step is to push toward the wall of the ostium of the side branch the struts that lay in the more distal part of the ostium. As a matter of fact, a final kissing performed with a balloon too small for the side branch or for the main branch may deteriorate even more the apposition of the stent struts toward the wall of the side branch (Fig. 2 in Ormiston et al. [7]). What is of paramount importance is to perform, before kissing, a high-pressure balloon inflation in the side branch in order to be sure to expand the stent fully at the ostium of the side branch. Following this step comes the kiss, which needs to be performed at medium pressure, usually 8 atm (when the two balloons are inflated together), to avoid any proximal dissection. All these concepts are well demonstrated in the in vitro model presented by Ormiston et al. [7]. Deflating the balloons simultaneously may also help to prevent any further distortion of the stent struts, avoiding incomplete apposition. In support of the in vitro findings of Ormiston et al. [7] is the finding that when the crush is performed with appropriate final postdilatation and kiss, the need for target lesion revascularization at the ostium of the side branch is reduced to single digits (data not shown).

What is evident from this experience is that the crush technique needs a kiss appropriately conducted. We should have known this from the beginning: "if you get a crush you should then kiss and if you kiss you should do it well."

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