



## Editorial

# Have a Crush, Kiss Twice, and Tell: How to Optimize Intervention for Coronary Bifurcation Lesions

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*See articles by Crimi et al., pages 906-914, and Morris et al., pages 852-859 of this issue.*

Bifurcation lesions account for 20% of all percutaneous coronary interventions (PCIs), are technically challenging, and are associated with worse outcome compared with simple epicardial stenoses.<sup>1</sup> For simpler bifurcation anatomies, a single stent approach is recommended (in the main branch only) with the provisional use of a second stent when flow becomes compromised in the untreated side branch owing to plaque shift or dissection.<sup>2</sup> A 2-stent strategy becomes necessary in complex bifurcation anatomies, such as when the large side branch is compromised by a severe, long stenosis at the ostium, when there is an acute-angled takeoff, or when a true distal left main bifurcation is present.<sup>3</sup> Because no 2-stent technique is suitable for all anatomies, myriad approaches have been described, such as the mini-crush, the culotte, and the T stentings. Of these, one stands out from the crowd: the double-kissing (DK) crush (Fig. 1). The term double-kissing was coined by Chen et al.<sup>4</sup> in China and refers to the idea that a simultaneous inflation of 2 angioplasty balloon catheters in the main and the side branches (thus kissing) is performed twice, once after the first stent (in the side branch) has been crushed, and again once the second stent is inserted in the main vessel. The multistep compulsory technique is meant to minimise strut malapposition at the carina and optimise the opening of the side branch. Compared with other approaches, the DK-crush approach requires additional procedure time, radiation exposure, and contrast volume.

International practice guidelines recommend DK-crush technique for left main bifurcation stenting but provide little guidance on the selection of approaches for non-left main bifurcation lesions.<sup>5,6</sup> Currently, no compelling evidence exists to promote the superiority of one technique over the other in terms of major clinical end points. Two

publications in this issue of the *Journal* bring new important information in this field: using a network meta-analysis, Crimi et al. expose the superiority of DK-crush over other techniques,<sup>7</sup> and Morris et al. describe how a refinement of the DK-crush called nano-crush may further the field.<sup>8</sup>

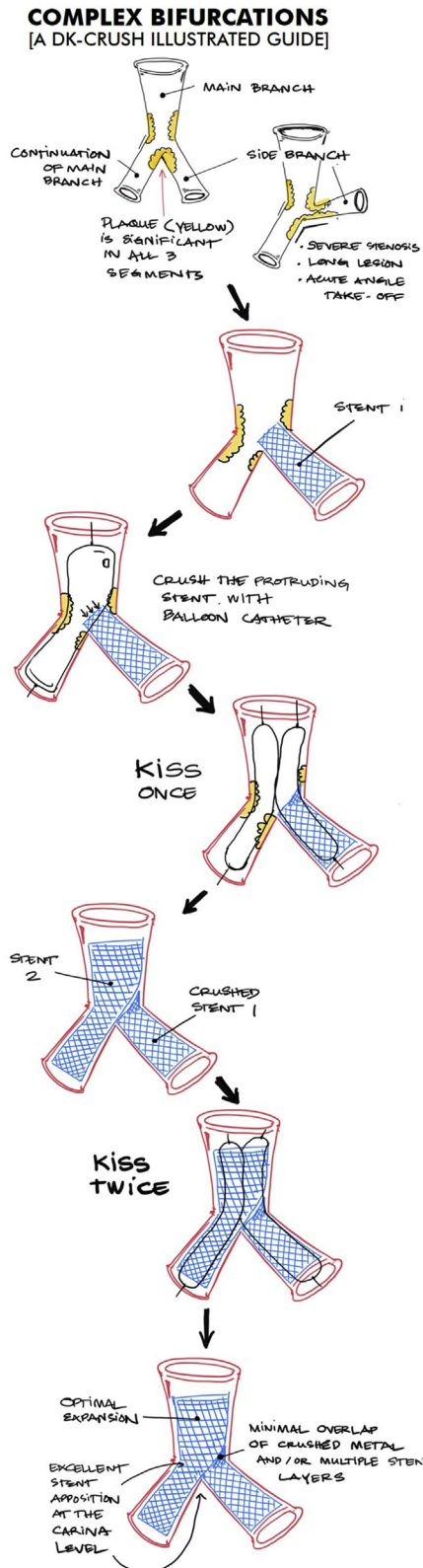
The single-stent approach (with provisional side-branch stenting) is the de facto comparator in randomized clinical trials (RCTs) testing novel 2-stent techniques. This lays a favourable ground for a network analysis in which multiple 2-stent strategies are compared indirectly across trials with the use of a common comparator. Likewise, because the rates of clinical events are relatively low in bifurcation trials, the pooling of studies is necessary to distill a meaningful signal on device-oriented clinical events (DOCE), beyond the less informative restenosis end points. To this end, Crimi et al. performed a systematic review and a network meta-analysis of 26 RCTs that compared several techniques and found DK-crush to be associated with the best reduction in the combined occurrence of cardiac death, target-vessel myocardial infarction, stent thrombosis, and target-lesion or target-vessel revascularization, with a risk ratio of 0.62 (95% confidence interval 0.42-0.92) compared with the provisional T-stenting technique over 10,339 patient-years.<sup>7</sup> With the use of a bayesian approach, DK-crush was found to have the highest probability of being the best technique among those explored to reduce DOCE in patients receiving coronary bifurcation PCI (Bayesian best rank = 92%). Of note, the evidence for DK-crush superiority was mainly driven by indirect estimations. The strengths of this meta-analysis are that it used contemporary evidence (22 of the 26 RCTs selected were published after 2010) and that most of the patients had true meaningful bifurcation lesions (Medina 1,1,1-0,1,1, or 1,0,1) with significant stenosis (> 50%) extending beyond the ostium of a sizeable (> 2.25 mm) side branch. As acknowledged by the authors, an important weakness is that many studies did not report DOCE as time to first composite event, so these events had to be estimated at the study level with the use of individual components of the composite outcome. This

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See page 800 for disclosure information.



**Figure 1.** Complex bifurcations.

might have led to an overestimation of the number of events. Study-level meta-regression could have helped to better understand the role played by varying baseline characteristics between study populations.

Now that a strong case has been made in favour of DK-crush by the Crimi et al. analysis, can the procedure be improved further? Morris et al. propose a refinement of the DK-crush called nano-crush, meant to minimize the amount of metal layers and strut overlap associated with the technique.<sup>8</sup> Nano-crush is achieved by positioning the side-branch stent with minimal protrusion into the main branch and then deploying another stent over an undeployed balloon in the main branch. The particularity of the nano-crush is that the first kissing occurs with the balloon catheter of the side-branch stent still in place. This has the effect of creating a neocarina, seemingly apposed and properly expanded, without having to cross crushed stent struts. Once achieved, stenting of the main branch, rewiring of the side branch and final kissing occurs as would be otherwise expected with a traditional DK-crush technique. Geometric modelling, benchtop silicone implantation, and computed tomographic reconstruction and fluid dynamic modelling demonstrated minimally disturbed blood flow. The DK nano-crush was successfully used in 9 patients with bifurcation lesions, with excellent angiographic outcomes and no adverse events over 12 months.<sup>10</sup> The DK nano-crush technique builds on the most promising developments in bifurcation PCI, simplifies the traditional DK approach, and possibly makes it less prone to acute thrombosis and binary restenosis. Experienced interventional cardiologists will likely fear stent entrapment in the main branch, because the neocarina is not crushed against the wall. Adequately powered real-world evidence and RCTs should validate this novel approach.

DK-crush techniques seem to be the best strategy in complex coronary bifurcation intervention. Crimi et al. demonstrated that when a 2-stent strategy is considered in a patient with a bifurcation lesion, a DK-crush technique reduces DOCE compared with other techniques, based on available RCTs. Morris et al.<sup>8</sup> suggest that the traditional DK-crush technique can be simplified and made more accessible.

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