

Selection of stenting approach for coronary bifurcation lesions



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Coronary bifurcation lesions are a challenging lesion subset of coronary artery obstructive diseases. With the rapid development of stent platforms, drug-coating techniques, a new generation of antiplatelet therapeutic drugs, intravascular imaging, and a better understanding of the abnormal flow dynamics around bifurcated areas, patients after stenting of coronary bifurcation lesions have shown a dramatic reduction in major adverse cardiac events (MACE). In the last decade, the European Bifurcation Club, a leading educational platform, has attempted to improve clinical outcomes in patients with coronary bifurcation lesions, as reflected in the annual updated consensus document¹.

Article, see page 1307

Other similar groups have emerged (almost 10 clubs built globally so far) and their numbers are continuously expanding. A chain of global clinical randomised trials has not only built on the solid foundation of provisional stenting for most bifurcation lesions but has also unveiled new bifurcation stenting approaches. However, there are still many issues which remain to be resolved.

The stent platform is correlated with clinical events after stenting for coronary bifurcation lesions: an expandable cell size determines the side branch (SB) ostial area after stenting the main vessel (MV), and the strut thickness affects the flow pattern with subsequent changes in shear stress and resultant intimal proliferation¹. Thus far, stents with ultra-thin struts have been warmly welcomed. A wider discrepancy in vessel diameter around bifurcated vessels is one of the features present in bifurcation lesions. Accordingly, the maximally expandable diameter of a given stent is another key element associated with stent failure. A crossed-over stent is always sized according to the distal MV or SB size,

and proximal overdilation using a very large balloon at a higher inflation pressure poses a risk of strut fracture, typically seen in stenting left main distal bifurcation lesions.

The complexity of bifurcation lesions is due to their complicated anatomy, including calcification, lesion length, diameter stenosis, vulnerability, and bifurcation angle. The Medina classification defines the presence or absence of plaques angiographically in three bifurcated vessel segments and therefore fails to provide critical anatomic variables correlated with stenting selection and clinical outcome. To resolve this issue, the ESC 2018 guidelines on myocardial revascularization² listed another three criteria for defining complex bifurcation lesions (SB diameter ≥ 2.75 mm, SB lesion length >5 mm, and difficulty in accessing the SB after MV stenting), which unfortunately lack strong clinical evidence. The percentage of complex bifurcation lesions according to the DEFINITION angiographic criteria (one major plus any two minor criteria)³ is reported to be 31%^{3,4}. These two studies consistently showed results favouring systematic two-stent approaches as best for complex bifurcation lesions. In contrast, provisional stenting is superior to upfront two-stent approaches for simple bifurcation lesions³, supported by the findings from the DKCRUSH-II study⁵ in which DEFINITION criteria-defined complex bifurcation lesions were seen in only 13.9% of cases. Obviously, the complexity of bifurcation lesions strongly predicts the occurrence of MACE. This finding was further confirmed recently by the DEFINITION II trial⁶, which included only complex bifurcation lesions, by using the DEFINITION criteria. In this trial, systematic two-stent techniques (DK crush was used in 77.8% of the lesions in the two-stent group) surpassed provisional stenting in terms of target

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lesion failure at one-year follow-up. However, why provisional stenting does not work well for complex lesions remains unclear.

The complex anatomy of bifurcated vessels requires an understanding of the specificities of lesions and the mechanisms of stent failure. Intravascular imaging-guided stenting procedures have significantly reduced the incidence of MACE in patients with all coronary artery diseases, but the clinical benefits for bifurcations are lacking. Two trials, DKCRUSH VIII (NCT03770650) and OCTOBER (NCT03171311), are ongoing. Their results will show the benefits of intravascular ultrasound and optical coherence tomography in guiding bifurcation stenting, respectively.

SB compromise (induced by plaque/carina shift, spasm, dissection, or thrombus formation), particularly abrupt closure, is most challenging during provisional stenting. Post-MV stenting, rewiring the SB from the “distal cell” is recommended. However, just a tiny channel at the ostial SB after stenting the MV would minimise the success of distal rewiring, a condition allowing the rewiring from the “proximal cell”. Theoretically, in SB rescuing, provisional stenting with a T stent (proximal rewiring) could be inferior to provisional stenting with the T-and-small protrusion (TAP) technique (distal rewiring), but lacks clinical data. Provisional stenting initially blocks the implantation of an SB stent. However, SB bail-out stenting cannot be avoided in some cases, ranging from 1%⁷ to 42%⁴, depending on lesion complexity. Thus, no clinical trial has shown the difference in clinical outcome between provisional stenting with one stent and with two stents. If provisional stenting with one stent has a lower rate of MACE, should provisional stenting with two stents be considered as an event or a complication? Should kissing inflation be performed routinely after MV stenting? More effort is urgently required to make provisional stenting as perfect as possible because of its central role in treating a large number of bifurcation lesions (mostly simple bifurcations).

Traditionally, systematic two-stent treatments consist of multiple steps; the inherent differences between them determine the different clinical outcomes. In fact, culotte stenting is a reverse provisional stenting, and both share a risk of SB occlusion after MV stenting. Recently, DK mini-culotte, a modified conventional culotte stenting technique, has received considerable attention⁸. Before the report of a large trial, we should be very cautious about the efficacy of DK mini-culotte stenting because it easily can be changed to mini-crush. On the other hand, the DK crush is not going to challenge provisional stenting for simple bifurcations. The short- and long-term benefits of DK crush for complex bifurcation lesions have been confirmed by serial studies^{4,6}. However, the DK crush technique is not flawless. Proximal SB optimisation (PSB) after SB stenting in DK crush, which was first demonstrated in the Coronary Bifurcation Summit meeting (CBS) (<http://www.cbssmd.cn>) by Dr Teguh Santoso (CBS 2012) and recently recommended by Dr Francesco Lavarra and Dr Massoud Leesar (CBS 2019), has been extensively accepted. DK crush needs proximal rewiring. For some cases (after balloon crush), Drs Goran Stankovic and Jun-Jie Zhang proposed the importance of rewiring from proximal-middle

cells if proximal rewiring failed (CBS 2020). More recently, we further addressed the importance of complete crushing based on our previous IVUS analysis. All of these findings offer the hope of a nearly mature DK crush technique.

Stenting bifurcations is an art more than a science. Combined efforts are being made in this field despite setbacks.

Conflict of interest statement

The author has no conflicts of interest to declare.

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